VOLUME TOC

DEQ Exhibit 6

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RAMACO

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RECLAMATION PLAN

Prepared by:
WWC Engineering

July 2015

RP.1 INTRODUCTION

The Reclamation Plan for RAMACO's Brook Mine was prepared by WWC Engineering (WWC) of Sheridan, Wyoming. The Reclamation Plan entails the procedures necessary to reestablish the environment of the mine. Areas within the permit boundary will be disturbed by mining activities. The procedures listed in this plan are designed to minimize the effects of disturbance activities.

The Brook Mine objective for reclaiming the land is to restore the land to it approximate original function and restore any communities on disturbed lands to their respective original states by constructing conditions that are equivalent or superior to the conditions that existed premining. However, this doesn't infer that all topography will be restored exactly to premining topography, and that all species previously established in the habitat will be fully restored.

RP.2 POSTMINING LAND USE

The postmining land uses for the Brook Mine permit area will be very similar to the premine land uses established as the baseline in Appendix D1.

RP.2.1 Postmining Land Use Classifications

The postmining land uses will be composed of multi-usage land, meaning the land will have multiple purposes similar to the premine conditions. The land classifications that will be established will include recreational and industrial land uses but the majority of the lands will be established for grazing. Exhibit RP.2-1 presents the proposed postmine land uses within the Brook Mine permit area.

RP.2.1.1 Grazingland Land Use

Grazingland land uses will consist of non-irrigated hay meadows, grazing rangeland, other ranching activities, and use by wildlife. Areas hilly in nature within the permit area will be returned to rangeland suitable for grazing. The majority of the postmine land use will be grazingland.

RP.2.1.2 Industrial Commercial Land Use

As discussed in Appendix D1, lands within the permit area have been used extensively for industrial purposes primarily mining. Postmine industrial land use may include rock quarries, oil and gas exploration and coal mining. These uses are similar to premining industrial land uses.

RP.2.1.3 Recreational Land Use

Lands that were established recreational areas before mining have been used for a variety of recreational activities. These lands will be reclaimed similar to the premine conditions to facilitate postmine recreation replicating premine recreation. The reconstruction of wildlife habitat and vegetative communities that support recreation activities (such as hunting) are further discussed in later sections of this plan.

A Wyoming Game and Fish walk-in area was present premining. The walk-in area will be reestablished in the post mine condition.

RP.2.1.4 Developed Water Resources

Permanent postmine impoundments will be constructed within the permit area of the Brook Mine. Permanent postmine impoundments will provide an additional beneficial land use. These impoundments will be used for stock watering purposes, and will provide wildlife habitat. By providing wildlife habitat, permanent impoundments also provide the potential for recreational use in the forms of hunting or wildlife observation. Permanent impoundments will be constructed in accordance with federal, state, and county rules and regulations and will be permitted through the Wyoming State Engineers Office (SEO). Hydrologic restoration is discussed in Section RP.8.

RP.2.2 Support and Maintenance Activities

Postmine land uses will be established through the construction of vegetation communities and wildlife habitats that mimic the conditions present before mining. Section RP.6 discusses the procedures to reestablish vegetation communities.

RP.2.3 Alternative Land Use

No alternative postmine land uses within the permit area of the Brook Mine are planned.

RP.3 CONTOURING PLAN FOR AFFECTED LANDS

The contouring plan for the disturbed lands will match the premining surface configuration as much as possible. Postmine topography (PMT) was designed to resemble the premining surfaces and to blend the postmine surfaces with native topography.

RP.3.1 Reclamation Schedule

In general, the reclamation schedule for the Brook Mine will follow the schedule of topsoil replacement as discussed in Section RP.5 of this report. Following topsoil replacement, revegetation procedures will begin as soon as possible thereafter. Discussion of revegetation procedures is presented in Section RP.6. Section RP.13 discusses the reclamation schedule in more detail.

RP.3.2 Reestablishment of Surface Configuration

The PMT is presented in Exhibit RP.3-1. The postmine land contours closely resemble the premining topography. The premining landscape consists of topography similar to much of the northern Powder River Basin (PRB) of significant topographical relief typified by open hills, narrow erosional channels, and steep scoria capped buttes and ridges separated by relatively short, incised, ephemeral drainages which ascend steeply from the valley floor of the principle Tongue River watershed and its local tributaries. The premining topography includes surface elevations ranging from 3,600 to above 4,100 feet above mean sea level (amsl). The postmine topography will retain this diversity of landscapes. Continuity between adjacent areas and postmine landforms will be provided.

As defined in Chapter 1 of WDEQ/LQD-Coal Rules and Regulations (R&R), the Brook Mine will be classified as an Approximate Original Contour (AOC) mine. The postmine configuration was developed through a mass balance model of the volume required to complete reclamation of the mine pits with the total spoil available for reclamation. The postmine topography was then adjusted to provide topography similar to the premining landscape and complement the natural terrain by blending the reclaimed contours with the native topography.

RP.3.3 Postmine Slope Analysis

Slope analysis of the postmine topography for the Brook Mine was conducted using the same procedures as the premine slope analysis detailed in Section D5.1.3 of Appendix D5. The results for the premine slope analysis are shown on Exhibit D5.1-1 and the results for the postmine slope analysis are displayed on Exhibit RP.3-2. Table RP.3-1 compares the average, minimum, and maximum slopes of the premining and postmining surfaces.

Postmine contours were modeled using corresponding, topographic computer grid files. The slope analysis was conducted using the slope zone analysis routine in the Carlson® software packages. Elevations for the postmining topography were determined for 100 x 100-foot grid cells over the entire permit area. The gridded elevations were then used by the Carlson® software program to calculate slope values for each cell and hatch the cell according to the slope zone. The program then determines the aerial extent of the slope zones and prepares a summary table. These values were used to calculate slope statistics, histograms, and cumulative frequencies. The distribution of slopes and slope cumulative frequencies for the postmine surfaces are presented on Exhibit RP.3-2.

RP.3.4 Erosion and Sedimentation Control Practices

Erosion and sedimentation control practices performed during mining and reclamation operations include the use of collector ditches, bypass ditches, and sedimentation/wastewater impoundments. Potential erosion in small areas will be controlled using alternative sediment control measures (ASCM). Further discussion of ASCMs and other erosion control practices can be found in Section MP.5 (Mine Plan) and Section RP.5.6 (Reclamation Plan).

RP.3.5 Drainage Reestablishment

Mining operations within the permit area of Brook Mine will disturb portions of the Slater Creek and Hidden Water Creek channels, and minor tributaries to these channels as well as minor tributaries of the Tongue River. Reclamation of these channels and drainage basins will entail reconstruction of these features. Section RP.8 further details the postmine hydrologic restoration.

RP.4 SPOIL REPLACEMENT

Spoil refers to overburden removed during the mining operations to expose coal, and does not include coal, subsoil, or topsoil, as defined in Chapter 1 WDEQ/LQD-Coal R&R. Spoils may also include overburden containing narrow coal seams of poor quality and portions of the coal seam that are intermixed with the surrounding material. These coal-laden materials will also be considered spoils and will be backfilled during reclamation. Spoil materials will be handled in accordance with procedures detailed in Section MP.4 of the Mine Plan.

RP.4.1 Regraded Backfill Monitoring and Sampling Program

Spoil materials will be monitored prior to backfill to ensure toxic, acid-forming, or other potential contaminants that could prevent revegetation are separated properly from plant growth media, and properly disposed. Details regarding the backfill monitoring program are included in Mine Plan Section MP.4.6.2. Sampling will be conducted in accordance with WDEQ/LQD Guideline Number 1. In general, sampling will include the collection of two composite samples to a depth four feet with a sampling grid set on 500-foot centers. The samples will be analyzed for constituents listed in WDEQ/LQD Guideline Number 1.

RP.4.2 Mitigation of Unsuitable Material

If material is determined to be unsuitable through sampling, further sampling will be conducted to determine the extent of the unsuitable material. Unsuitable material will either be covered with a minimum of four feet of suitable material, or removed and properly disposed. A minimum of 6 and 10 feet of suitable backfill material, excluding topsoil, will cover any unsuitable material under minor channels and major channels and their floodplains, respectively. Minor stream channels are those ephemeral in nature, while major stream channels are those intermittent or perennial in nature. Section D6.1 of Appendix D6 offers an in depth discussion of channel characteristics within the permit boundary. Floodplains of major channels are those areas inundated by the 100-year flow event. Permanent postmining impoundments will meet the same backfill quality criteria as defined for minor and major channels. Following mitigation procedures the area will be resampled and analysis repeated to ensure mitigation was successful.

RP.5 TOPSOIL REPLACEMENT

The term topsoil used in this section refers to the mixture of topsoil and subsoil as defined in Chapter 1 of WDEQ/LQD-Coal R&R for soil horizons A & E and B & C, respectively. Mine Plan Section MP.4 describes topsoil salvage procedures.

RP.5.1 Surface Preparation for Topsoil Replacement

Final graded surfaces will be prepared in a manner that minimizes erosion and provides a surface for replacement of topsoil that minimizes slippage. Finish grading will be achieved with front-end loaders, graders, and dozers, depending upon RAMACO's or an independent contractor's choice. Prior to topsoil replacement, the finished contour surface will be evaluated and scarified or ripped. This treatment relieves compaction, aids infiltration, promotes root penetration, and prevents topsoil slippage and instability.

RP.5.2 Topsoil Handling

Topsoil determined suitable will be salvaged using typical earth moving equipment. Topsoil sampling will be conducted ahead of stripping activities to ensure all suitable topsoil is recovered. Suitable topsoil (or topsoil substitutes) must meet the criteria as defined in Table I-2 of the WDEQ/LQD Guideline No.

1. Equipment operators will be properly trained in topsoil salvaging procedures, and topsoil salvaging procedures will be monitored by qualified personnel to ensure all suitable topsoil is recovered. A detailed description of topsoil salvage and stockpiling is provided in Mine Plan Section MP.4.2.

Dozers will work with front end loaders to replace topsoil, and will be followed by motor graders to smooth the final landform. Field personnel will monitor topsoil replacement to ensure proper replacement is achieved with an approximately uniform, stable thickness consistent with the proposed postmine land uses, contours, and surface water drainage systems. Topsoil will be ripped or scarified, as necessary, to prevent overcompaction and promote revegetation.

Special topsoil handling required for wetland mitigation is discussed in Section RP.9.

RP.5.3 Schedule for Replacement

Topsoil replacement will be conducted as soon as feasibly possible following final backfill grading to minimize the amount of time topsoil must be stockpiled. Topsoil replacement sequence is shown on Exhibit RP.5-1. Details regarding topsoil replacement activities will be discussed in the Annual Report. The removal schedule of topsoil and proposed topsoil stockpile locations are discussed in Section MP.4.2 of the Mine Plan.

RP.5.4 Topsoil Depth and Quality

The volume of topsoil to be replaced will be limited by the quantity of suitable premining in-place soil. Subsoil that is determined to be suitable as determined by field methods or chemical analysis may be mixed and removed with topsoil. Suitable topsoil and subsoil will be segregated from spoil or waste materials. Appendix D7 details soil depth and quality. Topsoil analyses indicate a range of 0 to 72 inches of soil will be available to spread on final backfilled graded areas. A weighted average of topsoil salvage depths was determined from soil depths collected during baseline studies. The average topsoil replacement depth will be staked at a depth of 18 inches in the field. The actual replaced depth may vary plus or minus 6 inches. Local variations of topography and equipment limitations may cause minor differences in topsoil replacement depth. Replacement depth will be reevaluated during the renewal process to verify that adequate topsoil will be available for reclamation.

Postmining soils will differ somewhat from premining soils with respect to morphology and chemistry. These differences are expected to be minor, with pH, sodium adsorption ratio (SAR), saturation percentage, and electrical conductivity (EC) all well within suitability ranges. Likewise, selenium, boron, calcium carbonate, coarse fragment percentage, and soil consistency values will be within suitability ranges. This expectation is reasonable, as only soils in good and fair suitability classes will be salvaged. In the event that not enough suitable topsoil is salvaged for use in reclamation, selected spoil material may be used as a topsoil or subsoil substitute or supplement. It must be determined that the substitute soil is equal to, or more suitable for sustaining vegetation than the existing topsoil or subsoil and that it is the best available in the permit area to support revegetation. In addition, the suitability of the replacement soil must be determined by utilizing the process outlined in WDEQ/LQD Guideline 1.

Replaced soils are anticipated to have a loamy texture. Organic matter content of the upper six inches of soil will probably be substantially less than premining surface soil organic matter content. Soil amendments will be used, if necessary, to ensure vegetation establishment. Soil organic matter content will increase once vegetation and nutrient cycling are reestablished.

RP.5.5 Prime Farmland Reconstruction

No prime farmland will be disturbed by mining activities.

RP.5.6 Erosion Control and Conservation Practices

Replaced topsoil will be protected from excessive compaction and wind and water erosion until vegetation has been established. Erosion of replaced soil will be controlled by adhering to the approved postmining contours to minimize the slope of recontoured and resoiled land; reestablishing a vegetation cover on replaced soil as quickly as possible; and recognizing soils with high erosion potential during soil recovery and, when possible, ensuring that they are mixed with less erosive soil material during stockpiling and/or replacement. Sediment control procedures as discussed in Mine Plan Section MP.5, will be used until Sediment Control Release has been approved.

Rills and gullies occurring in redistributed soil precluding the achievement of the approved postmining land use or the reestablishment of vegetative cover will be rectified. Any soil having been eroded will be replaced as needed to ensure the minimum approved depth and the areas will be reseeded or replanted as needed.

RP.5.7 Soil Amendments

When necessary, nutrients and soil amendments will be applied in the amounts determined by soil test or field trials to reapplied topsoil, subsoil, or suitable material so adequate nutrient levels are available to reestablish vegetative cover. If topsoil stockpiles have existed more than one year, nutrient analyses will be conducted to determine if the application of soil amendments will be needed.

Redistributed soil materials will be sampled and tested for macronutrient content (N, P, K) to determine whether fertilization is necessary. Results of soil fertility tests will be kept on file at the Brook Mine. If fertilization is required, application rates will be formulated to achieve soil macronutrient levels capable of promoting plant growth, productivity, and diversity. Fertilizer and mulch will be applied concurrently with seed on any steep slopes that are selected for hydroseeding. Vegetative characteristics such as vigor, color, growth rate, diversity, etc., will be monitored to determine soil fertility.

RP.6 REVEGETATION PRACTICES

The mine will restore a diverse permanent vegetative cover on all affected lands of the same seasonal native variety and/or a mixture of species that will support the postmine land uses. Modifications may be necessary as reclamation and mining technologies progress, or in the event of changes in site conditions or regulatory requirement.

The revegetation plan has been designed to meet short- and long-term reclamation goals of restoring the land to the usefulness and activity it sustained prior to surface mining by:

1. Controlling erosion and sedimentation;
2. Reestablishing a self-sustaining vegetative cover which is comparable to premine conditions; and
3. Restoring livestock grazing, wildlife habitat, watershed condition, and aesthetic values to meet the approved postmine land use objectives.

RP.6.1 Cover Crops

As a general rule, cover crops will not be planted because permanent seed mixes contain rapidly growing species capable of site stabilization. Cover crops will, however, be used on an as-needed basis for stabilization of disturbed areas which would otherwise be subject to erosion. These crops may be used in conjunction with permanent and temporary seed mixtures or they may be used alone as a short-term treatment during times of the year when conditions are marginal for seeding permanent and temporary mixtures. Cover crops can increase snow accumulation, provide organic matter, reduce wind erosion, assist in developing soil structure, and improve water infiltration.

Annual grasses (millet, barley, oats or wheat) will be seeded with a drill at the rate of 10-30 pounds pure live seed (PLS) per acre on those areas where cover crops are desirable. In areas where a drill cannot be used, seed will be broadcast at double the drill seeded PLS rate/acre.

Mulch or other equivalent alternative methods may also be used to control erosion and enhance soil moisture conditions. Mulch materials will be applied at a rate of 1 to 2 tons/acre. Weed free straw mulch will generally be preferred for use; however; native grass, weed free hay may be used when straw mulch is not readily available. After being applied, mulch will be crimped into the soil using the proper equipment.

Alternative methods to cover crops and mulching may also be used to control erosion and enhance moisture conditions. These procedures include companion crops, spring tooth harrowing, pitting, deep ripping, chiseling, and seeding with a no-till drill. All agricultural practices will use contour farming techniques to minimize erosion and enhance moisture holding capacity. The method(s) used will depend upon the slope, season and type of vegetation to be seeded.

RP.6.2 Premine/Postmine Vegetative Units

Premining species composition, diversity, and vegetation communities are discussed in detail in Appendix D8. The mine proposes to reestablish 7 major postmining vegetative communities which approximate the premining vegetative communities including areas identified as wetlands. The postmining vegetative communities will be: shrubland, bottomland grassland, upland grassland, water, hayland, disturbed, and wetlands and other aquatic resources. One minor community will be established that is based on modifications to these seed mixtures or seeding sites. The shrubland revegetation mixture will be seeded adjacent to rock piles to simulate the rough breaks community. The bottomland grassland revegetation mixture will applied around the periphery of permanent impoundments and postmining lowland areas around ephemeral streams. The relationship of premining vegetation communities to postmining revegetation types are discussed below. Table

RP.6-l provides a comparison of premining vegetation communities and postmining revegetation communities.

Revegetation seed mixtures are presented in Tables RP.6-2; the postmining vegetation communities are shown on Exhibit RP.6-1. Rock piles which simulate rough breaks habitat for wildlife are discussed in Section RP.7. The interim seed mixture for stockpiles and other temporary sites are also in Table RP.6-2. The postmine communities of water and disturbed will not include revegetation. Disturbed includes the postmine road network. Wetland mitigation is discussed in Section RP.9.

RP.6.2.1 Upland Grassland Community

The upland grassland community replaces the disturbed portions of the premining vegetation communities of upland grassland, reclaimed grassland, scoria grassland, prairie dog modified grassland, and pine juniper woodland. Dominant species in the premining vegetation communities that are included in the revegetation mixture are sandberg bluegrass, western wheatgrass, and green needlegrass.

Postmining areas revegetated with the upland grassland mixture are expected to evolve to a variable grassland vegetation community, elements of which will resemble upland, scoria, and prairie dog modified grassland vegetation types. The major portion of the upland grassland vegetation unit will resemble the premining upland grassland community, but areas with minor alterations in soil, moisture, and topographic conditions, will be present within this unit.

RP.6.2.2 Shrubland Vegetation Community

Dominant premining big sagebrush shrubland species that are included in the revegetation mixture include: big sagebrush, bluebunch wheatgrass, and western wheatgrass. The shrubland seed mixture will be planted on uplands similar to that of the premining big sagebrush shrubland community.

The rough breaks vegetation habitat is anticipated to be reestablished in and around clusters of rock piles which will be constructed on the reclaimed surface. These rock piles are described in greater detail in Section RP.7. Areas surrounding rock piles will be broadcast with the shrubland mixture. Species typical of rough breaks shrubland are also included in the shrubland seed mixture.

RP.6.2.3 Bottomland Grassland Vegetation Community

The postmining bottomland grassland community will serve to restore the premining communities of bottomland sagebrush grassland and riparian woodland. A relatively large number of species have been included in the revegetation mixture. The majority of species included in the bottomland grassland seed mixture is native to riparian woodland and bottomland sagebrush grassland communities in the permit area. Revegetation of impacted wetlands is discussed in Section RP.9.

RP.6.2.4 Hayland Vegetation Community

The postmining hayland community will serve to restore the premining community of agricultural land. The majority of species included in the hayland seed mixture are typical of agriculture land community in the permit area. Species included in the seed mixture include crested wheatgrass, alfalfa and slender wheatgrass. The hayland seed mixtures may be altered to achieve a certain harvest quality at the discretion of landowners and with approval from WDEQ.

RP.6.2.5 Premining Vegetation Types or Mapping Units Eliminated from Postmining Landscape

Riparian and pine juniper woodland premining communities will be replaced by bottomland and upland grassland communities, respectively. However, Brook Mine will restore these habitats by replacement of trees in these communities to a number equal to premine. Reclaimed grassland, scoria grassland, prairie dog modified grassland types will be replaced by upland grassland communities. Rough breaks mixed shrubland premine community will be replaced with the shrubland postmining community. The rabbitbrush shrubland vegetation community is not anticipated to be disturbed by mining activities.

RP.6.2.6 Species Selection

Selection of plant species for revegetation are based on premine species occurrence, establishment potential, growth characteristics, soil stabilizing qualities, livestock palatability, commercial availability and postmine land use objectives. Redistributed soil and substrate properties (texture, coarse fragment content, water holding capacity, permeability, and erosion hazard) have also been considered. The use of native species has been emphasized in the permanent revegetation mixtures. As new releases of species are made, they will be considered for inclusion in the revegetation mixtures. Species evaluations will be made on reclaimed sites throughout the life of the operation and alterations may be made to seed mixtures with WDEQ approval.

In the event that seed for primary species is not available, alternatives will be considered which match the life form and morphology of the primary choice only with WDEQ approval.

RP.6.2.7 Seeding Methodology

Permanent revegetation mixtures will be planted in late fall and/or early spring (March). Planting at these times should take advantage of select fall/spring precipitation events. Seeding dates are weather-dependent and therefore not rigidly set. Any areas requiring vegetative stabilization between spring and fall planting dates maybe seeded to a cover crop or other appropriate stabilization methods as described in Sections RP.6.1 and RP. 6.10.

Seed mixtures reported in Tables RP.6-2 vary somewhat between mixtures. Cover crops will consist of annual grasses (barley, wheat, and millet), and will be seeded with a drill at the rate of 10-30 pounds PLS per acre, or broadcast at a rate double the drill rate PLS per acre.

Three methods of seeding will be employed at the Brook Mine: drill, broadcast drill, and broadcast. These three seeding methods should result in the reestablishment of a diverse shrub and perennial grass dominated vegetative cover on these reclaimed areas. Overall, the resulting vegetation should provide a diverse habitat.

The broadcast seeding will be employed on rocky areas, on steeper slopes, on small disturbances, and for small seeded species, including the shrub component of select revegetation mixtures. Seed will be mixed frequently to discourage settling. Where possible, broadcast seeded areas will be chained, harrowed, or two pass seeded to cover the seed. Where appropriate, broadcast-seeded areas will be dozer-tracked perpendicular to the slope to control erosion. On small or inaccessible sites, hand raking will be used to cover seed.

When hydroseeding is used, seed, fertilizer and mulch will be sprayed in one application. Where hydromulching is used, a second application will spray the remainder of the cellulose fiber mulch (to achieve a total of one ton per acre) and a tackifer (at the manufacturer's recommended application rate).

The mine may consider using alternative seeding methods to encourage the establishment of warm season grasses and shrubs. Drill seed boxes can be adjusted so that alternating rows can be seeded to warm season grasses and shrubs (using a shallow depth setting) and cool season species. Another technique involves broadcast seeding warm season grasses and shrubs in islands that have not been drill seeded with cool season species. When rangeland drills are utilized, drilling depths will generally range from ¼ to ½ of an inch.

Several of the grass and shrub seeds in the revegetation seed mixes may require special handling techniques. Scarification, stratification, or dewinging may be necessary for germination.

RP.6.3 Planting

Depending on results of shrub seeding, the mine may conduct supplemental shrub planting. Potential planting rates and methods will be discussed with the WDEQ/LQD prior to undertaking planting.

Various species of trees will be planted within the disturbed area during revegetation. Brook Mine will document any trees using WDEQ/LQD acceptable procedures before they are removed. Typically, Brook Mine plans to restore trees on a one to one basis; however, species classified as noxious weeds will not be replaced. Trees species documented in the riparian woodland habitat that may be reclaimed include cottonwood, peachleaf willow, and green ash. In the pine juniper woodland habitat tree species that may be reclaimed include native species ponderosa pine and Rocky Mountain juniper. The introduced species of russian olive is categorized as a noxious weed species and therefore will not be replaced.

Stock will be delivered to the site as close to the time of planting as possible. No stock will be handled when the air temperature is below freezing, and no plantings will be made when frost is in the soil. A planting site will be cleared to a depth and diameter necessary to position the seedling. Seedling roots will be placed against the rear vertical wall of the hole, spreading the roots fan-wise. The hole will be partially filled with moist soil and firmed, then completely filled and firmly tamped. A basin will be formed around the seedling or sapling stem to trap water. Mulching may be employed to conserve moisture and reduce competition. Trees will be protected from livestock and wildlife until they are large enough to sustain browsing.

RP.6.4 Evaluation of Revegetation Success

Evaluation of revegetation success will be based upon WDEQ/LQD-Coal Chapter 4, Section 2.d.(ii) and its applicable subsections. Postmining land uses identified in Section RP.2 will be individually evaluated against their specific success standard. Standards where cover, production, and shrub density apply will be demonstrated through quantitative means equal to or better the success standards using methods and statistical analyses approved and published by WDEQ/LQD as required by OSM rules. A confidence interval of 90 percent will be used for statistical analyses.

RP.6.4.1 Vegetation Cover and Productivity

The extended reference area concept, as defined in WDEQ/LQD-Coal Chapter 1, Section 2, will be used to evaluate postmine vegetation cover and productivity. The extended reference area is comprised of undisturbed portions of pertinent vegetation types within the study area. All vegetation communities outside of areas disturbed by operations will serve as the extended reference areas, as seen in Table RP.6-6. The extended reference areas will remain unaffected over the course of operations, will be as large as practical, and will be no smaller than 2 acres. Henceforth, use of the term "reference area" in this text is synonymous with extended reference area. As per WDEQ/LQD-Coal Chapter 1, Section 2, the assessment of vegetation cover will separately address absolute cover of vegetation and absolute cover of total ground, where:

- Absolute cover of vegetation is the percent of the ground surface which is covered by the vertical projection of all live vascular plants (ignoring minor gaps between branches and holes in the canopy) to the ground surface, and;
- Absolute cover of total ground is the sum of the cover values for vegetation, litter, cryptogams and rock cover.

Absolute values of the percentage of cover will be used to evaluate reclamation success.

Cover and productivity data will be gathered concurrently on both the revegetated areas and extended reference area to provide the information necessary to determine the success of the revegetation efforts. Cover and productivity data will be evaluated for reclamation success using procedures specified by WDEQ/LQD-Coal Chapter 4, the Handbook of Approved Sampling and Statistical Methods for Evaluation of Revegetation Success on Wyoming Coal Mines, and consultation with WDEQ. The same methodology used to sample baseline vegetation communities, cover, and productivity will be used to evaluate vegetation at the time of reclamation. Sampling methodology is described in detail in Appendix D8.

Statistical adequacy, as specified by WDEQ/LQD-Coal Chapter 4, will be achieved for all postmining cover and productivity data.

According to WDEQ/LQD-Coal R&R Chapter 4, Section 2(d)(ii)(B), prior to bond release at the Brook Mine, vegetation success for grazingland and pastureland will be measured by:

1. The vegetation cover of the affected land is shown to be capable of renewing itself under natural conditions prevailing at the site, and the absolute total vegetative cover is at least equal to the cover on the reference area or technical standard;
2. The annual herbaceous production is at least equal to the annual herbaceous production is at least equal to the annual herbaceous production on the reference area or technical standard;
3. The species diversity and composition are suitable for the approved postmining land use; and
4. The requirements in (1), (2), and (3) are all met during the same two out of four years beginning no sooner than year seven of the bond responsibility period.

RP.6.4.2 Species Diversity and Species Composition

Species diversity and composition will be evaluated in terms of number of species present and relative contribution of each species to the community. Factors to be considered in evaluating composition and diversity are: capability of the reclaimed land to support the postmining land use; ability and potential for the plant communities to perpetuate themselves; influence of volunteer species on the plant community; the original species list; and the Motyka Index of Similarity. The Motyka Index will be used as a tool for relative comparisons of life forms (perennial native cool season grasses, perennial introduced cool season grasses; warm season grasses, annual grasses, forbs, subshrubs, and shrubs) between the reference areas and reclaimed areas.

The Motyka Index formula is:

$$IS_{mo} = \frac{2w}{a + b} \times 100$$

Where

w = sum of the lesser values in common between Area A and Area B

a = sum of values for Area A

b = sum of values for Area B

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The minimum acceptable percentage of similarity will be mutually agreed between the mine and WDEQ/LQD prior to evaluation for final bond release.

It is understood that in the event a less stringent standard is developed in the future, the mine will have the option of amending the postmining species diversity goals accordingly.

RP.6.4.3 Postmine Grazing

The ability of the postmine communities to sustain grazing will be quantitatively and qualitatively evaluated based upon the results of a controlled grazing plan for postmine lands.

When the mine determines that a sufficient number of permanently reclaimed management units are available for grazing, a grazing plan will be prepared and submitted to WDEQ/LQD. Upon mutual agreement between the mine, WDEQ/LQD, the surface landowner, and/or the grazing lessee, the grazing plan shall be implemented. Results from the grazing plan will be used to document achievement of the postmine land use.

RP.6.4.4 Self-Renewing Plant Communities

The ability of the plant communities to reproduce and sustain themselves will be subjectively evaluated. Observational data on permanently reclaimed plant communities provided in the Annual Reports, interim monitoring data, data gathered during the evaluation of postmining cover, productivity, species composition, and species diversity will form the basis of this subjective evaluation.

RP.6.4.5 Shrub Density Goal and Standard

In accordance with DEQ/LQD rules and regulations all eligible lands shall be subject to the standard of at least 20 percent of eligible land shall be restored to shrub patches supporting an average of one shrub per square meter. Option II of permit wide full shrub density standard with no reduction in areal extent or density was selected for the Brook Mine Shrub Density Goal.

RP.6.4.5.1 Non-eligible and Eligible Lands

Incorporation of the Shrub Density Goal and Standard required determination of eligible lands. Eligible lands refer to all lands to be affected by a mining operation after August 6, 1996 which carries the grazingland land use designation as defined in Chapter 1 of WDEQ/LQD R&R. Pastureland land use with a full shrub density greater than 1 shrub/m^2 is also eligible.

Non-eligible land status categories were initially identified. These included non-affected areas (i.e., areas not to be disturbed by mining activities) outside of the proposed mine disturbance boundary but within the permit boundary. Any disturbed areas created by non-mining activities such as oil and gas service roads and facilities, pre-existing county and private roads, and previous land owner disturbances were identified as non-eligible. Agriculture lands identified during the baseline assessment were identified as non-eligible because the shrub density was not sampled due to lack of shrubs.

RP.6.4.5.2 20% Shrub Restoration Standard – Option II

Table RP.6-3 presents the area disturbed by Brook Mine which are eligible lands subject to the 20% Shrub Density Standard. Based on the shrub density portion of Appendix A, WDEQ/LQD Rules and Regulations, the Option II Permit-wide full shrub density standard was selected as the Brook Mine Shrub Restoration Standard. Under this Shrub Density Standard, Brook Mine will restore 1 shrub per square meter on 20% of the reclaimed eligible lands.

In order to complete the calculations required for determination of the Shrub Standard, as outlined in Appendix A, WDEQ/LQD Rules and Regulations, shrub density data for each premine vegetation community type was required to determine residual shrubs.

Calculations for the Brook Mine Shrub Density Standard were completed and are shown in Tables RP.6-3, RP.6-4 and RP.6-5. Table RP.6-4 also presents the number of individual shrubs that will be replaced at a density of 1 shrub/m^2 and the area of postmine shrubland reclamation. Within that density requirement: big sagebrush (dominant full shrub with the highest weighted average relative density [0.46/m²]) density must, at a minimum, be 0.33 shrubs/m²; residual shrub (all primary full shrubs with relative densities of 0.10 and any approved full shrub) density must, at a minimum, be 0.33 shrubs/m²; and approved subshrub density can, at a maximum, be 0.33 shrubs/m². Modifications to the mine disturbance boundary will ultimately require modification of the Brook Mine Shrub Density Standard. Due to the complexity of the shrub density standard calculations, shrub density standard modifications will be prepared for a significant change in the proposed mine disturbance boundary (e.g., a 10% or greater difference in acreage); otherwise, the shrub density standard will be modified, as necessary, every 5 years for cumulative changes affecting less than 10% of the original mine disturbance acreage.

RP.6.4.5.3 Reclamation Methodology

The shrubland revegetation mixture is shown in Table RP.6-2. The listed rates are for drill seeding only; broadcast rates will be doubled.

This seed mixture would be seeded according to following methods: 1) hand broadcasting, broadcast drill, or mechanical broadcasting the shrub\subshrubs and grasses\forbs in the late fall or winter (this option would include hydroseeding); 2) drill seed the grasses\forbs and broadcast the shrubs\subshrubs in late fall or winter; 3) drill seed the grasses\forbs and shrubs\subshrubs when firm seed bed exist.

When possible, direct haul topsoil will be used in these shrub mosaics to take advantage of residual seed of additional shrubs, cool season grasses and forbs. When direct haul topsoil is available, only the shrubs will be seeded. If direct haul topsoil is not available, then both the grasses\forbs and shrubs\subshrubs would be seeded according to the shrubland revegetation mixture.

To supplement broadcast or drill seeding rates of the species listed in the shrubland mixture, containerized stock of individual species may be planted to increase the likelihood of survival to meet the final shrub standard. Tubelings will be planted with a spade, hochad or similar appropriate equipment to minimize soil compaction near roots.

Herbivore protection may be necessary after initial planting and will consist of such measures as electric fence, plastic protection tubes, spraying deterrent for smaller herbivores, fencing entire shrub patches from larger herbivore use such as antelope and deer, or other appropriate measures. If areas are fenced from larger herbivore use for a minimum of five years, these areas will be readily distinguishable from surrounding reclaimed areas. If these areas are not fenced, the general area will be marked in the field by steel fence posts or other suitable permanent or semi-permanent marking.

RP.6.4.5.4 Reclamation Monitoring and Bond Release

In order to monitor success of seeding efforts, 0.5 square meter density quadrats will be sampled in each shrub mosaic during the first two growing seasons. In Year 3, density belt transects (1m x 100m) will be utilized. Sample numbers will be size dependent and not tied to sample adequacy calculations. In general sampling intensity will follow WDEQ Guideline 14. Ten random samples will be selected on areas up to100 acres and one additional sample location for every additional 10 acres in increase. After Year 3, the monitoring of these shrublands will be tied to the normal interim monitoring schedule of the Brook Mine. Data will be collected and summarized by full and half shrub species.

Reclaimed lands will be jointly used by livestock and wildlife. For purposes of interim monitoring, the presence or lack of grazing for both herbivore categories will be documented for each shrub mosaic.

Qualitative descriptions will be used to assess the species diversity and species composition of shrub areas scheduled for final bond release. The derived species lists and quantitative density data will be evaluated against the proposed land uses. Vegetation parameters, other than shrub density, will be primarily used to evaluate this issue. Once the shrub density standard is met or passed, the reclaimed area will be capable of withstanding grazing pressure at least comparable to that sustained prior to mining and will provide suitable postmining wildlife habitat.

RP.6.5 Tree Density

In accordance with Chapter 4, Section 2(d)(i)((I) of WDEQ/LQD-Coal R&R; trees will be returned to a number equal to the number established for premining baseline studies in Appendix D8.

RP.6.6 Noxious Weeds

Reclaimed land will be inventoried for noxious weeds, as defined in Chapter 1 of WDEQ/LQD-Coal R&R, during cover, production, and shrub density evaluations. Reclamation will be considered successful if noxious weeds are absent or if an approved noxious weed control plan is in effect. Specific measures to limit noxious weed presence include:

- Use of seed certified as containing no prohibited noxious (designated) or restricted noxious (designated) weed seed;
- Use of noxious weed-free mulch;
- Interim revegetation and prompt final revegetation of disturbed areas using rapidly establishing species;
- Periodic evaluation of noxious weed presence; and
- Control programs, as necessary, developed in conjunction with the Sheridan County Weed and Pest Office.

RP.6.7 Revegetation Monitoring

A detailed revegetation monitoring plan per WDEQ/LQD Guideline Number 14 will be submitted to WDEQ/LQD within one year after permanent reclamation has been initiated.

The mine will conduct periodic revegetation monitoring in order to:

- Identify potential "problem areas" on the revegetated lands. Further analyses of soils, vegetation, or other parameters could identify reasons for any failure and facilitate site specific correction before final bond release is compromised.

- Release an area from sediment control, as discussed in Chapter 4, Section 2(f)(vi) of the WDEQ/LQD-Coal R&R.
- Attain incremental bond release for vegetation as described in Chapter 15, Section 5(a)(ii) of the WDEQ/LQD R&R.
- Document progressive development of revegetation toward attainment of full bond release criteria described in Chapter 4, Section 2(d)(ii) of the WDEQ/LQD Rules and Regulations.
- Identify a date for initiation of the two consecutive years of vegetation sampling necessary to document achievement of reclamation success standards.
- "Fine-tune" revegetation techniques (including seedbed preparation, seed mixtures, seeding methods, planting methods, mulching, fertilization, etc.). Any such modifications would be submitted to WDEQ/LQD for review and approval prior to implementation.

RP.6.7.1 Areas to be Monitored

Revegetation will be sampled based on seed mixture, age of seeding, site conditions, management practices or other factors influencing revegetation. Given longevity of the operation, it is anticipated that several years of revegetation may be combined to facilitate logistics of sampling. Combining years of seeding will depend on the ultimate approach for requesting bond release. For example, if revegetation practices do not substantially change for years six through eight of seeding, and it is anticipated that years six and seven would be on the same bond release schedule as year eight (because these areas represent a logical grazing unit), all three areas may be combined for sampling.

Sample parameters/procedures: The following parameters will be sampled:

- Percent vegetation cover by species
- Percent total vegetation cover (total for all species --non stratified)
- Percent total ground cover (=vegetation + litter + rock)
- Percent bare ground

- Annual production of perennial vegetation by dominant species(and minor species by life form) in each area -- e.g. young stands dominated by annual forbs would be sampled by morphological class
- Shrub density

Additionally, a species list will be prepared. Other parameters such as density, frequency, or diversity may be measured or calculated depending on goals of the monitoring period.

Sampling methods will follow those presented in Appendix D8 unless alternative methods are proposed and approved by WDEQ/LQD prior to sampling. Sampling methods will be the same between revegetated areas and the reference area (when both are sampled). Consistent methods will be used throughout the duration of monitoring, and monitoring will be conducted on approximately the same dates each year.

Monitoring of permanent revegetation will be conducted before and after grazing. For postgrazing monitoring and final bond release evaluations, livestock will be excluded from the revegetation or sample sites will be protected by range cages or other temporary exclosures.

RP.6.7.2 Sampling Intensity

Sample size for interim monitoring will be based on 1) size of the area to be sampled, 2) homogeneity within the sampled area and 3) specific goals of monitoring for the sample period. A general guideline for sampling will be one sample location (random plot) per ten acres with not less than ten plots for a sample unit up to 100 acres. One sampling location will be added for every additional ten acre increase up to maximum sample size of fifty for each individual sampling area. Confidence levels will be calculated for total ground cover, total vegetation cover and total herbaceous production.

RP.6.7.3 Sampling Interval

Revegetated areas will be sampled two times during interim monitoring (years three and five) and twice for final bond release (years seven and ten). Monitoring prior to year three will be subjective although some density measurements may be conducted to evaluate initial success. In the event the bond period for specific monitoring areas exceeds ten years, additional sampling will occur every five years after the third sample until final bonding release.

RP.6.7.4 Data Analysis/Reporting

Data will be analyzed as per WDEQ/LQD R&R. Revegetation trends will be compared within a revegetation unit to evaluate changes during the monitoring period. Results of any monitoring will be submitted to WDEQ/LQD as part of the Annual Report.

RP.6.8 Irrigation

The mine does not plan to irrigate postmine revegetated surfaces within the permit area.

RP.6.9 Protection of Newly Seeded Areas

Newly reseeded areas will be protected by fencing designed to meet WDEQ/LQD Guideline Number 10 and surface owner specifications. Fences will be designed to exclude sheep, cattle, and most other grazers.

Fences will be left in place for a minimum of two years; the need for continued fencing will be determined after this initial period and will be based on a subjective evaluation of revegetation success. Fences will be removed only upon agreement with the mine, the surface landowner, and WDEQ/LQD. Fences may be left in place until the reclaimed land is adequately stabilized or bond is released.

The only vehicles allowed on reclaimed areas will be for monitoring purposes and livestock management. Livestock grazing will be restricted during operations and for at least two years after seeding. Wildlife and livestock damage to revegetation will be controlled as necessary by selective fencing or chemical repellent. Noxious weeds will be controlled throughout the life of the operation to reduce the seed source available to invade reclaimed areas.

RP.6.10 Management Plan For Revegetated and Reference Areas

Management considerations for revegetated areas include erosion control, soil fertility, noxious weed control and grazing.

Reclaimed slopes will be inspected for rills and gullies and for evidence of slumping, cracking or mass movement. Damage to the reclaimed surface from erosion will be repaired by regrading, installing temporary flow restrictors (such as straw bales) and reseeding to establish vegetation. Erosion control measures such as jute netting, erosion control blankets or other means may be utilized if site conditions require.

Post-seedling emergence will be observed to monitor soil fertility. If plant nutritional deficiencies appear, micronutrient testing will be included in the sampling program and appropriate corrective measures will be taken. Reseeding will occur only after attempts have been made to determine the cause of any failure.

Noxious weeds will be controlled throughout the life of the operation to reduce the seed source available to invade reclaimed areas. Revegetated areas will be qualitatively evaluated annually to assess weed populations. A weed control plan will be developed in cooperation with the Sheridan County Weed and Pest Office, if necessary.

When a sufficient number of acres have been reclaimed to create a viable grazing management unit, and it has been determined that vegetation can sustain grazing, a grazing plan will be submitted to WDEQ/LQD. The grazing plan requesting first-time grazing will include the following:

- A map showing each reclaimed land unit and its tracking designation.
- The date that each unit was seeded with an approved, permanent seed mixture.
- A permit citation referencing the approved seed mixture applied.
- The type of protection previously afforded each reclaimed unit.
- The number of acres in each unit and the total acreage for all first-

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time grazing units.

- Interim vegetation monitoring data.

The grazing plan will be based on sound range management principles. The purpose of grazing reclaimed lands is to demonstrate that postmining vegetation is self-sustaining and capable of supporting the proposed post-mining land use.

Once vegetative cover has been achieved on disturbed lands, strict management procedures will continue to be used to ensure the establishment and maintenance of stable biotic communities. The procedures described in this section will enable Brook Mine to reclaim all disturbed surfaces to at least the level of premining productivity

Land within the permit area not needed for mining operations will continue to be used for its associated premining use.

RP.7 WILDLIFE RESTORATION

The greatest impact to wildlife from mining activities at Brook Mine will be the temporary loss of habitat. However, surface disturbance at the Brook Mine will be minor compared to conventional surface mines located in the Powder River Basin due to the implementation of highwall mining. Highwall mining operations are further discussed in the Mine Plan. The primary land disturbance will occur within and directly adjacent to select ephemeral drainages within the mine area. Reclamation of the disturbed wildlife habitats will focus on providing habitat features which promote maximum species diversity. To attain diverse vegetation throughout the permit area, various measures will be implemented during habitat reclamation. These measures include incorporation of diverse slopes, surface undulations, development of postmine impoundments, shrub and tree establishment and the incorporation of rock piles.

RP.7.1 Postmining Habitats

Brook mine plans to integrate several postmine vegetation communities to promote diverse and stable postmine habitats similar to those that were present premine. Brook Mine plans to reestablish eight of the eight wildlife habitats discussed in Appendix D9 that are planned to be disturbed within the Brook Mine Permit Area. These habitats and the postmining vegetation units or land features to which they will correspond are listed below:

Wildlife Habitat	Vegetation Unit or Landform
Sagebrush Shrubland	Shrubland Community
Rough Breaks Mixed Shrubland	
Upland Grassland	Upland Grassland Community
Reclamation	
Juniper Woodlands	
Riparian Woodlands	Bottomland Grassland Community
Stockpond/Water	Postmine Impoundments
Hayland	Hayland Community

Sagebrush shrubland and rough breaks mixed shrubland habitats will be restored by the postmining shrubland community. Upland grassland and reclamation habitats will be restored by the postmining upland grassland community. The two woodland habitats, juniper and riparian, will be reclaimed with upland and bottomland grassland postmining vegetative communities, respectively. As discussed earlier, the woodland communities will be restored by replacing trees. The hayland habitat will be reclaimed by the postmining hayland community. Further discussion of the postmine vegetative communities for Brook Mine are shown in Section RP.6.

Postmine impoundments and reclaimed ephemeral channels will provide a source of water for wildlife species throughout the mine area similar to premine conditions. Postmine impoundments constructed after mining are discussed in the final hydrologic restoration section. To simulate the premining rough breaks habitat several rock clusters will be established on reclaimed lands as described in the later discussion.

RP.7.2 Seed Mixtures

Plant species seed mixture selection for revegetation are based on premine species occurrence, establishment potential, growth characteristics, soil stabilizing qualities, commercial availability and postmine land use objectives. Further discussion of seed mixtures and revegatation operations may be found in Section RP.6.

RP.7.3 Crucial or Critical Habitats

As discussed in Appendix D9, wildlife habitats designated by state or federal agencies as crucial or critical are not present within the permit area. Also, no species identified currently as threatened or endangered was identified within the Brook Mine permit area. If future wildlife surveys should identify a threatened or endangered species within the mine area, appropriate state and federal agencies will be contacted and acceptable mitigation measures will be implemented.

RP.7.4 Aquatic Habitat

Aquatic habitat will occur in and around the permanent impoundments and ephemeral drainages. Stockponds disturbed by mining activities will be reconstructed to approximate their premining size. Two additional postmine impoundments will be constructed. The location of both the reconstructed stockponds and additional postmine impoundments may be seen in Exhibit RP.3-1. Minimal permanent aquatic habitat will be provided for fish and other true aquatic species, but seasonal high water levels will support some amphibious species and provide water, nesting sites, and protection for many avian and mammal species.

The established aquatic habitats occurring in Goose Creek and the Tongue River will not be disturbed by mining activities. As discussed in Appendix D9, ephemeral drainages within the mine area are not viable fisheries; however, reclamation of these areas will provide habitat for a variety of wildlife species. Further discussion of stream channel reclamation is presented in Section RP.8.

RP.7.5 Wildlife Enhancement Practices

Brook Mine plans to employ various wildlife enhancement practices during reclamation operations to promote diverse and stable habitats similar to those present before mining. These practices include shrub and tree restoration, tree nest sites, rock pile construction and postmine impoundment construction.

RP.7.5.1 Shrub and Tree Restoration

Revegetation of the postmine landscape will incorporate shrub and tree restoration practices to restore the habitats present premining.

Shrubland seed mixture administered during revegetation will include dominant grasses and shrubs of the premining sagebrush shrubland habitat. The diversity of species in this revegetation mixture will include dominant species like big sagebrush, which will improve the capacity of this habitat to support a variety of big game and non-game mammals and birds.

Riparian and juniper woodland habitats will be reclaimed to a condition that closely resembles their premining counterparts. Native tree species of cottonwood, green ash, peachleaf willow, ponderosa pine, and Rocky Mountain juniper were among the species documented during premine studies that will be replaced during reclamation operations. Nesting and foraging habitats for raptors and other birds will be provided through tree reclamation. Importance will be placed on the reestablishment of the riparian habitat in particular, for its nature to provide for the greatest diversity and abundance of species as documented by premining studies.

RP.7.5.2 Rock Pile Construction

To imitate the premining rough breaks habitats disturbed by mining operations, the postmine topography will be similar to premine conditions. Additional rough break habitat will be added by construction of rock pile clusters.

Large boulders and rocks salvaged during mining will be selectively placed on reclaimed areas. Potential sites for these rock piles may include the crests of reclaimed hills, gentle slopes and adjacent to permanent impoundments. Rock piles will provide perches for raptors and passerine birds, cover for small mammals and cottontails, and possible den sites for coyote or red fox. The area around rock piles will be seeded with the shrubland mixture.

Distribution of rock piles will be a function of reclaimed topography, land use and material availability. Rock pile density will vary greatly within reclaimed habitat and will be a function of availability of materials as mining progresses. Rock pile size and shape will vary considerably, depending on availability of materials, distance of transport, reclaimed topography, etc.

An attempt will be made to create a diversity of rock piles. A few rock piles may consist of one large boulder, 3-5 feet in diameter, placed at prominent points or open areas to serve as raptor perches. For the most part, the minimum rock pile size will be 3-5 boulders, 3-5 feet in diameter, piled together at one location. Other rock piles may be considerably larger but constructed of smaller rocks, with the final size, shape and height to be determined by material availability, rock integrity, and configuration of the placement site. Some rock piles may be "jumbles" where virtually all rocks are above ground, with a high point usable by raptors. Others may be more linear, and may be dressed with topsoil on the uphill side to blend more aesthetically with the slope and create more burrow locations; topsoil may be thinner just downslope of the rock pile, to provide an exposed rock face, burrow openings, etc.

Whenever possible, rocks will be direct hauled from stripping areas to reclamation areas. If sufficient material is present, some rocks may be stockpiled for later placement.

RP.7.5.3 Postmine Impoundment Construction

The construction of several postmine impoundments will benefit a multitude of wildlife species. Postmine impoundments will provide habitat for waterbirds, reptiles, and amphibians. Postmine impoundments will be designed to allow ease of use by big game and other wildlife species. Further details of postmine impoundment construction are found in Section RP.8.

RP.7.6 Wildlife Monitoring Program

Monitoring of wildlife will be conducted in accordance with the Wildlife Monitoring Plan found in the Mine Plan Addendum MP-8. In addition, Migratory Birds of High Federal Interest and Raptor Mitigation Plan is included in Mine Plan Addendum MP-9.

RP.8 FINAL HYDROLOGIC RESTORATION

RP.8.1 Drainage Basin Reconstruction

The final hydrologic reconstruction plan for drainage basins affected by mining within the Brook Mine permit area is provided on Exhibit RP.8-1. Several drainage basins are intercepted by the permit area and therefore evaluated in Appendix D6 and in this section of the Reclamation Plan. The drainage basin of Slater Creek and Hidden Water Creek, and some of their associated tributaries will be affected by mining and reclamation. Postmine drainage basin parameters are presented in Table RP.8-1. Postmine drainage basin parameters were developed using methods as described in Appendix D6 using the postmining topography. Due to the mining methods and minor disturbance, the postmine drainage basin parameters remain mostly unchanged from premine values. As is evident from the comparison of drainage basin parameters in Table RP.8-1 and Exhibit RP.8-1 to Table D6.1-1 and Exhibit D6.1-2, the overall hydrologic balance will remain largely unchanged, despite the disturbance in the drainage basins of Slater Creek and Hidden Water Creek.

RP.8.1.1 Discharge Estimates

Flood estimates for the drainage systems designed for the reclaimed surface were calculated by the rainfall/runoff computer program HEC-HMS, a computerized version of the SCS Triangular Hydrograph procedure (U.S. Army Corps of Engineers, 2009).

The postmining drainage basin parameters shown in Table RP.8-1 were used as input for the computation of postmining flood estimates for each of the major drainage systems composing the reclaimed surface. The results of the postmining flood studies are provided in Table RP.8-2 for the 6-hour events and Table RP.8-3 for the 24-hour events for comparison to the premining flood estimates derived in Appendix D6 and shown in Tables D6.1-5 and D6.1-6. Comparison of these tables show the majority of stream designations experienced changes in event peaks and volumes of less than one percent when compared to the premining results. Discharge values calculated do not include routing through impoundments. A comparison of runoff estimates using HEC-HMS and Miller methods is presented in Table RP.8-4. Input parameters and complete results for the HEC-HMS and Miller (2003) methods can be found in Addendum RP-1 and Addendum RP-2, respectively. Further discussion of these methods and the variance of the results they produce can be found in Appendix D6. Precipitation values for the runoff estimates were determined from the NOAA Precipitation-Frequency Atlas of the Western United States, Volume II for Wyoming, as discussed in Appendix D6.

RP.8.1.2 Channel/Floodplain Design

Channels and floodplains will be designed to be erosionally stable, and to blend with the natural topography. As these features are constructed, verification that their construction conformed to these designs will be submitted in the Annual Report. Separate channel reaches were specified for reclaimed channels where either storm event flow or channel slope varied significantly, and separate flood estimates were computed for each specified channel and tributary reach. These postmine flood estimates were used with baseline geomorphic characteristics presented in Appendix D6 to provide a basis for the design of the reclaimed channel and floodplain cross sections. Stream reaches for which designed cross sections are provided are identified in plan on Exhibit RP.8-1 and in profile on Exhibit RP.8-2.

Channels located at the head of a drainage basin will typically be constructed as topographic swale with parabolic cross sections. These channels will be similar in geometry to the first order channels of the premining surface. In general, the swales will have constructed top widths of 50 to 300 feet, depths of 2 to 3 feet, and the shape will generally correspond to SCS parabolic swale design as shown on Figure RP.8-1. It can be expected that additional first order channels may develop as the reclaimed surface matures. This process is a natural occurrence in the morphology of drainage basins and should not be expected to produce excessive erosion. These upland channels will be shaped by conventional earthmoving equipment during the grading of the backfill to the reclaimed contours. The broad, parabolic swales thus created will function in a manner similar to the premining upland swales by concentrating overland flow and directing surface runoff to the downstream, higher order channels. All channels will be shaped prior to topsoil replacement. This way, the spoil surface beneath the topsoil will be sufficiently traveled on to provide an adequate degree of compaction prior to topsoil placement.

The geometry of the reclaimed channels and floodplains proposed for other channels will be similar to premining channel configurations by providing shallow, grassed, trapezoidal sections or parabolic system.

Uniform flow calculations utilizing the results of the postmine flood studies were used to evaluate the geometry specified reach of the reclaimed channels. If inadequate flow capacity or inappropriate mean channel velocities were calculated, the cross section geometry was redefined band analyzed again until stable cross sections were developed with adequate flow capacities. Reclaimed channel cross sections and the results of the hydraulic calculations for the main channels and tributaries are presented on Figures RP.8-2 through RP.8-9.

During reclamation, reclaimed channels and floodplains will be constructed with smooth transitions between reclaimed and undisturbed reaches. Channels will be revegetated with the bottomland and wetland seed mixtures to minimize erosion. Although the reclaimed channels and floodplains are designed to be as erosionally stable as the premining system, it is expected that there will be some adjustments following reclamation. These adjustments may take the form of minor scouring and bank erosion as the reclaimed channel attempts to achieve equilibrium with the sediment supply and regional discharge conditions. Most of these adjustments will be self-healing, but if localized erosion problems become significant, an attempt will be made to determine the cause of the problem and the disrupted parts of the channel system will be repaired.

Hydraulic properties of the reclaimed Slater Creek and Hidden Water Creek channels were determined using the U.S. Army Corps of Engineer's HEC-RAS© River Analysis System. The primary input parameters modeled were: peak discharge for the 2-year, 24-hour and 100-year, 24-hour storms (as determined by HEC-HMS watershed model); Manning's roughness value "n" for the channel and overbank areas; and station/elevation data for stream cross sections within the study area. The cross section interval utilized in the model was 500 feet to match that of Appendix D6. Channel hydraulic values for flow depth, water surface width, flow area, Manning's "n," hydraulic radius and mean channel velocity can be found in Table RP.8-5. Input parameters and complete results of HEC-RAS modeling can be found in Addendum RP-3.

RP.8.1.3 Geomorphic Design

In addition to hydraulic factors, which have an obvious impact on the morphology of a drainage system, geomorphic factors were considered in the design of the postmine drainage network for the reclaimed surface. Geomorphic characteristics are influenced by many factors including lithology, topography, substrate texture, sediment load, and climate. Many of these factors will be changed during the processes involved in mining and reclamation. Table RP.8-1 provides an analysis of the postmine geomorphic parameters for the drainages which will be affected by mining. Refer to Appendix D6 for the premine geomorphic parameters.

RP.8.2 Permanent Impoundments

Permanent impoundments are proposed for the reclaimed surface. The design of postmine permanent impoundments was based on material postmine land use, drainage area, hydrologic characteristics, and overall morphology. The topsoil replacement will follow procedures the same as other reclaimed areas except that topsoil or suitable subsoil high in clay content will be used to line impoundments. The postmining impoundments will be designed to allow ease of use for wildlife and livestock.

The approximate locations of both new and reclaimed impoundments are shown on Exhibit RP.3-1. The permanent impoundments will be used as a source of water for livestock and wildlife and will mitigate the loss of small depressions and stock ponds as a result of mining. A net increase in the storage capacity of the impoundments within the permit boundary is predicted as two new impoundments are proposed. As discussed in Section RP.2, permanent postmine impoundments will be used for stock watering purposes and will provide wildlife habitat. Permanent impoundment water quantity and quality follow standards established in Guideline 17 and WDEQ/LQD Rules & Regulations. The construction of permanent impoundments will be subject to the landowner's consent, and WDEQ/LQD and State Engineer's Office approval. Prior to the construction of postmining impoundments, SEO approved plans for impoundments must be submitted for inclusion in the Reclamation Plan. RAMACO will obtain permits from the SEO for impoundments which will comply with any implications to the Yellowstone Compact, and will act in accordance with guidelines outlined prior to construction of postmine impoundments. A Reclamation Plan revision must be approved by LQD before the construction of impoundments.

Table RP.8-6 presents drainage area, capacity, and estimated mean annual flow for each of the new proposed postmine impoundments. The reservoir mean annual flow as estimated by the relationship determined by Hadley and Schumm (1961) is provided for comparison to the proposed capacity for each impoundment. While the report was originally developed for the Upper Cheyenne River Basin, the lower Tongue River Basin where the mine is located closely resembles the vegetative and climate characteristics of the Upper Cheyenne.

RP.8.2.1 Permanent Impoundment Information

Detailed designs for postmining impoundments will be developed and submitted to WDEQ/LQD and the State Engineer's Office and WDEQ/LQD for approval prior to construction. Since most of these impoundments will include wetland mitigation features, some design information presented in Section RP.9 is applicable to permanent impoundments.

RP.8.3 Aquifer Reconstruction

Significant recharge or discharge areas at the Brook Mine are discussed in Appendix D6. The aquifers are generally recharged in the northwest, and the water flows down the geologic dip to the southeast. Sources for recharge to the Carney Seam include Carney burn (scoria) that is adjacent to the coal seam, open Carney mine pits north of the permit area, regions where the Carney seam subcrops into Slater Creek or Tongue River alluvial material, and infiltration from precipitation into the Monarch burn stratigraphically above the Carney Seam. The Masters Seam does not outcrop in the permit area; however, it may subcrop into Slater Creek alluvial material. Sources of recharge for the Masters Seam are assumed to include infiltration from overlying strata, communication with river alluvium, and Masters Seam outcrops west of the permit area. The upper portions of scoria, which are generally unsaturated, be mined and used for road surfacing at the Brook Mine. Significant impacts to the recharge areas are not anticipated because the recharge areas lie primarily outside of the permit area. Additionally, because highwall mining is the primary method of mining, infiltration through overlying strata will not be affected. The saturated scoria strata, which are the strata that provide recharge to the underlying units, will generally not be disturbed by mining.

As discussed in Appendix D6 the overburden in the mine area is not a continuous aquifer. The coal seams are aquifers that have water in portions of the permit. No special handling of materials will be conducted to construct aquifers at the Brook Mine. The mining method minimizes the disruption of the overburden. In areas of the trenches the backfill will come into contact with the adjacent coal and therefore become the aquifer in these areas.

The estimated Postmine Potentiometric Surfaces for the reclaimed aquifer for the Masters and Carney Seams are presented respectively on Exhibit RP.8-3 and Exhibit RP.8-4. As described in Section RP.8.5.3, the postmine potentiometric surface is expected to recover to premine conditions. Therefore, the postmine potentiometric surfaces in Exhibits RP.8-3 and RP.8-4 match the premine potentiometric surface. Mining operations will alter the coal aquifer parameters such as the hydraulic conductivity and storage coefficient where active mining occurs. However, as described in Addendum MP-3 these alterations are not expected to impact the long term potentiometric surface. Rather, only the time it takes for the aquifers to recover to premine levels will be impacted.

RP.8.4 Postmine Hydrologic Monitoring

RP.8.4.1 Groundwater Monitoring

Postmine groundwater monitoring wells will be installed after topsoil replacement has been completed. When possible, wells installed during baseline studies and operations will continue to be utilized. The wells that will be included in the postmine groundwater monitoring program are listed in Table RP.8-7. The locations of the monitoring wells at Brook Mine are shown on Exhibit RP.8-5.

Groundwater quantity and quality will be monitored until final bond release to determine the extent of the disturbance to the hydrologic balance. The intent of the postmine groundwater monitoring efforts will be to document the availability of groundwater and the suitability of the groundwater quality to be consistent with the approved postmine land use. Postmine monitoring wells completed within the affected aquifers should demonstrate that yields documented prior to mining have not been compromised and the water quality is adequate for postmine land use. The baseline studies showed these aquifers were of limited quantity therefore, it is not anticipated that they will be any better in the postmine conditions.

Backfill wells to be constructed will be located to 1) replace monitor wells mined through during the life of the mine, and 2) adequately assess the reestablishment of groundwater levels and water quality. The basic design components for all reconstructed wells are shown on Figure RP.8-10. All monitoring data will be included in the Annual Reports to WDEQ/LQD.

Initially, the groundwater monitoring program will consist of annual water level measurements and water quality sampling. This frequency of monitoring will be followed until a definite trend is established, and with approval from WDEQ/LQD, the monitoring plan will be reduced. All groundwater monitoring and testing data will be included in the Annual Reports.

Single-well or multi-well, constant-discharge aquifer pumping tests will be conducted to determine the transmissivity and storage coefficient of the backfilled spoil material. The mine will consult with WDEQ/LQD to determine the number of spoil wells that will be tested. Pumping tests will be conducted once backfill well has 25% to 50% of its perforated interval saturated, or as a component of the final incremental bond release package. If the saturated thickness of the spoils and/or the yield is not adequate to conduct a long-term pumping test at any particular spoil well, a slug test (injection- or recovery-type) will be conducted as an alternative. Aquifer tests will be conducted to determine the spoil aquifer's hydraulic characteristics (i.e., hydraulic conductivity and storage coefficient).

Infiltration rates for the reclaimed spoils will be determined by conducting infiltration tests; the number and location of which will be discussed with WDEQ/LQD as areas of reclamation are completed. Recharge capacities and rates of groundwater level recoveries will be documented with the groundwater levels recorded by the postmine monitoring wells.

The groundwater quality samples will be analyzed for the parameters listed in Table RP.8-8. Certain parameters may be eliminated from analyses as data indicate, with prior approval from WDEQ/LQD. Sampling procedures will be in accordance with the most current version of WDEQ/LQD Guideline Number 8.

All monitoring wells will be plugged and reclaimed according to procedures outlined in WDEQ/LQD R&R and in the Mine Plan.

RP.8.4.2 Surface Water Monitoring

As discussed in Appendix D6, surface water monitoring stations were established in the project area for baseline studies. A postmine surface water monitoring program will be implemented after reclamation is complete in respective drainage areas. This program will aid in the evaluation of the erosional stability and runoff characteristics of the postmine topography, and provide a comparison of the postmine surface water regime with the surface water characteristics described by baseline monitoring efforts. The monitoring sites included in this program are listed in Table RP.8-9. The locations of these sites are shown on Exhibit RP.8-5.

Water quality samples will be obtained as indicated in Table RP.8-9. The water samples will be analyzed for the parameters listed in Table RP.8-8. Sampling procedures will be in accordance with the most current version of WDEQ/LQD Guideline Number 8. All surface water monitoring data will be included in the Brook Mine's Annual Reports.

RP.8.4.3 Postmine Impoundments

WDEQ/LQD-Coal R&R Chapter 2, Section 6(b)(vi) states that if a permanent postmine impoundment is proposed for final reclamation, five criteria will be required for a complete application:

A. Written consent will be provided from the surface landowner, if different from the mineral owner.

B. A description will be provided that explains the proposed use of the impoundment.

C. A statement of the source, quality, and quantity of water available to be impounded, and a statement regarding its suitability for recreational, irrigation, and/or livestock or wildlife watering. If it cannot be demonstrated to WDEQ/LQD that the water quality and quantity will be suitable for the postmining land use, the mine will provide an alternate plan.

D. The mine may be required to monitor surface and groundwaters in order to determine that upon completion of the operation, the water quantity and quality will be consistent with the approved postmining use.

E. A description of the construction of the impoundment to meet the requirements of WDEQ/LQD-Coal R&R Chapter 4, Section 2(g)(ii):

1. Dams will contain an overflow notch or spillway so at to prevent failure by overfilling and washing. Overflow notches and spillways must be protected to prevent erosion.

2. The slopes around all water impoundments must be gentle enough so as not to present a safety hazard to humans or livestock, and so as to accommodate revegetation. Variations from this must be approved by WDEQ/LQD based on locality.

3. Mineral seams and other sources of possible water contamination within the impoundment area must be covered with overburden or stabilized in such a manner to prevent contamination of the impounded water.

4. Bentonite or other mire-producing material within the impoundment basin shall be removed or covered with materials that will prevent health hazards to humans, livestock, or wildlife.

Reservoir stage and water quality will be conducted until bond release for all postmine impoundments. Water quality grab samples will be obtained from each of the proposed permanent impoundments listed in Table RP.8-9. Permanent impoundments Big Horn No. 8 Reservoir and Big Horn Scale House Reservoir are not planned as being disturbed directly by mining activities and therefore, will not be monitored during the postmining period. Quarterly samples will be obtained each year as water availability permits. The samples will be collected to represent a range of reservoir stages. The parameters to be monitored and the sampling techniques to be used are listed on Table RP.8-8. Reservoir stage as measured by staff gages will be reported with each water quality sample. Additional monitoring conducted for permanent impoundments used for wetland mitigation is discussed in Section RP.9.

The water quality samples from the postmine impoundments will be used to determine if the water is suitable for approved postmine land uses using WDEQ/LQD Class III groundwater standards, as suggested by LQD guideline No. 17 for replacement and enhancement stockponds. If the quality in an impoundment is found to be suitable for such use during five consecutive years, a request for termination of monitoring will be made and the structure left as a permanent feature. If the quality is found unsuitable for two consecutive years, the pond will be evaluated to determine how to improve the quality, which may include adjusting the capacity, relocating the impoundment, or removing the impoundment. The steps to be taken will be discussed with WDEQ prior to their implementation.

The water levels of the postmine impoundments will be monitored to determine if sufficient water is being stored in the reservoir. Water should be present in the impoundment a portion of the year to provide a water source for stock and wildlife.

All impoundments with an embankment will be inspected regularly during construction and immediately after construction by a qualified registered professional engineer or qualified professional specialist under the direction of a qualified professional engineer. These individuals will be experienced in reservoir embankment construction. Immediately following each inspection, a report will be prepared and certified by the engineer describing the construction work observed and conformance with approved designs. All inspection reports will be retained at the mine and submitted in the Annual Report to WDEQ.

After completion of construction and until final bond release or removal, all impoundments with an embankment will be inspected annually by a qualified registered professional engineer, or by a qualified professional specialist under the direction of the qualified professional engineer. These individuals shall be experienced in impoundment construction. Immediately following each inspection, a report shall be prepared and certified by the engineer describing:

1) Existing and required monitoring procedures and instrumentation;
2) Depth and elevation of any impounded water;
3) Existing storage capacity;
4) Aspects of the dam that may affect its stability or present any other hazardous condition; and
5) If the impoundment is being maintained in accordance with the approved design.

All annual inspection reports will be retained at the mine site and annually submitted to WDEQ/LQD.

In addition to post construction annual inspection requirements, all impoundments with embankments will be inspected during each of the intervening calendar quarters by a qualified individual designated by the operator. These inspections will look for appearances of structural weakness and other hazardous conditions.

Those impoundments subject to 30 CFR 77.216 shall also be inspected in accordance with 30 CFR 77.216-3.

If any examination or inspection discloses a potential hazard, the operator will promptly inform WDEQ of the finding and emergency procedures formulated for public protection and remedial action. If adequate procedures cannot be formulated or implemented, WDEQ will be notified immediately.

Impoundments meeting the criteria of 30 CFR will comply with the requirements of 30 CFR 77.216. Any plan required to be submitted to the District Manager of MSHA under 30 CFR 77.216 will also be submitted to WDEQ as part of the permit application.

RP.8.5 Postmine Impacts on the Hydrologic Balance: Hydrologic Consequences

RP.8.5.1 Introduction

The Reclamation Plan for Brook Mine is specifically designed to minimize impacts to the hydrologic balance. In this section, significant surface water and groundwater aspects of the hydrologic balance are identified, and the anticipated changes and effects of these changes on the hydrologic balance are described.

RP.8.5.2 Surface Water

Appendix D6 identifies the drainages at the Brook Mine as predominantly ephemeral. Slater Creek is an intermittent stream while Hidden Water Creek is an ephemeral stream. Minor tributaries contributing to these streams are ephemeral in which water only flows in response to precipitation and snowmelt events.

The most apparent potential impact of mining on the surface water hydrologic balance is the slight change of watersheds and their characteristics. The redistribution of soil and revegetation will change the infiltration rates of the soil, and the runoff curve numbers, which will contribute to a slight change in runoff volumes and velocities. Because the postmine topography will closely resemble premine topography, drainage areas will remain essentially unchanged. Postmine storm event calculations are shown in Table RP.8-2 for the 6-hour runoff events and Table RP.8-3 for the 24-hour runoff events. These can be compared to the storm event calculations for premining conditions provided in Appendix D6. In comparing these calculations, a slight change in event peaks and volumes can be distinguished. The majority of stream designations experienced changes in event peaks and volumes of less than one percent when compared to the premining results.

Mining should not significantly alter the erosional state of Slater Creek or Hidden Water Creek. Mining will only alter the Hidden Water Creek channel for a short period of time, during which the flow will still be allowed to pass mostly unaffected through a diversion. Only a small portion of the Slater Creek channel will be altered by the addition of a haul road and subsequent culvert. In addition, small tributaries of both Hidden Water and Slater Creek will be affected by mining activities. Once mining activities are complete, all channels that have been altered by mining activities will be reclaimed to closely resemble the premining geomorphic characteristics of the altered channel. Channel cross sections will be reclaimed as discussed in Section RP.8.1.2.

As noted in Section RP.8.1.2, channels will be designed with a floodplain capable of holding the peak discharge from the 100-year, 6-hour event. Channels will be parabolic. The parabolic shape will simulate premining conditions of the channels. The channels will be constructed to have non-erosive flow velocities, thereby reducing the potential for erosion.

The drainage basins will be reconstructed with drainage densities similar to the premining basins. Discussion of the premining drainage density is found in Appendix D6. This can be compared to the postmine drainage density listed in Table RP.8-1. All of these factors indicate that there should be no significant change between the premining and postmining geomorphic characteristics.

Postmine impoundments planned for the postmine landscape should not significantly alter the surface water quantity available on or downstream of the permit area. The impoundments consist of primarily stock ponds that existed prior to mining and will be reclaimed to a state very close to that of premining. The two additional postmine impoundments reside within very small drainages that make up only a small fraction of the total contributing surface water quantity of the permit area.

The quality of surface waters is not expected to be altered after reclamation is complete. Backfill standards for unsuitable overburden and waste materials are discussed in the Mine Plan. Sedimentation reservoirs, ditches, and ASCMs will capture all waters from affected areas prior to release downstream. These control structures and measures will remain in place and use as sedimentation control until the water quality from affected areas meets appropriate standards. The quality of surface waters will be no worse than the quality identified during the premining baseline studies discussed in Appendix D6.

Because the quality and quantity of surface waters will not be significantly altered by mining, no impacts to surface water rights downstream from the Brook Mine Permit Area, or the potential development of future water rights, are expected.

RP.8.5.3 Groundwater

In Appendix D6 the overburden is shown to consist predominantly of fine-grained clastics having low permeability and rates of groundwater movement. The overburden encountered during baseline monitoring activities indicate that the overburden is predominantly dry. Due to the mining methods no long term impacts are anticipated for the overburden.

The seams which will be mined are predominantly dry in the western portion of the permit area and eastern portions have been affected by coal bed natural gas development. Mining will remove portions of the coal aquifer. Drawdown of the potentiometric surfaces in the coal seams will occur during mining near the active mine areas. A detailed discussion of drawdown during mining is included in the groundwater model presented in Addendum MP-3. It is anticipated that the potentiometric surface will recover to approximate premine conditions. Premine seepage areas occurring at the intersection of the potentiometric surface and the surface topography are expected to reestablish after the postmine potentiometric surface recovers. As noted in Section RP.8.2, several permanent impoundments will be constructed after mining is complete. These impoundments are topographically higher than the potentiometric surface, but will be constructed in backfill material with very low permeability. Therefore, the impoundments are not expected to contribute to or receive a significant amount of water from the groundwater system.

There are no long term impacts to water rights anticipated. The coal was not a targeted water supply in the vicinity of the mine. This is primarily due to the fact that a portion of the coal is dry and there are other more reliable sources.

Water quality in the postmine aquifer is expected to be similar to premine condition. The highwall mining operation does not require large area of spoil materials and large portions of the coal will remain. The highwall mining operations will leave open caverns where coal was previously present. Eventually, the caverns may cave in causing minor changes to the hydrologic system. Since the coal pillars left around the mined out portions of coal will still be largely intact, the aquifer will still be in place even if subsidence occurs. Therefore, any potential subsidence effects are not expected to significantly impact the hydrologic system. The subsidence may cause short-term increases in the TDS in the water. However, these impacts would be localized only to the area of subsidence and would be expected to naturally attenuate shortly after any subsidence occurred. As described in Addendum MP-3, there is only one existing water supply well that has been identified within the permit boundary and all the other water supply wells identified are outside of the permit boundary. The well inside the permit boundary will be mined through so it will be impacted. However, predicted impacts to the other wells were short term and largely very minor. Since most of the wells are located outside of the active mining area, no significant water quality changes are expected. During mining and backfilling, water quality impacts are expected to be localized to the areas mined and not impact water supply wells outside of the active mining area.

Mining of coal will require removal and eventual replacement of the overburden as shown on Exhibit RP.3-1. The disturbance to the overburden may affect water quality not only in the overburden, but also in aquifers hydraulically connected to the overburden. Due to the mining methods this is minimal compared to other mines in the Powder River Basin. These water quality changes can be qualitatively predicted from the overburden mineralogy and projected postmine hydrology.

RP.9 WETLAND MITIGATION

RP.9.1 Introduction

Wetlands within the permit area are valuable components of premining and postmine land use, providing forage and water for livestock and wildlife, and habitat for herptiles and avifauna. Additionally, these areas provide important hydrologic functions including flood attenuation and sediment retention.

This mitigation plan presents specific details for mitigation of wetlands and Other Aquatic Resources (OAR,) as defined in Appendix D10, at the Brook Mine to compensate for these areas impacted during mining. The U.S. Army Corps of Engineers (USACE) has not issued a jurisdictional determination for the proposed Brook Mine. As such the information within this section is subject to change pending USACE determination. Information regarding the USACE jurisdictional determination for the Brook Mine will be incorporated into the permit once a determination is made.

RP.9.2 Life of Mine

Total wetland and Other Aquatic Resources are summarized in Table D10.2-1 of Appendix D10. Drainages constitute the majority of the jurisdictional wetlands and OAR within the Brook Mine permit area.

The purpose of final wetland restoration is to reclaim jurisdictional wetlands and OAR that will be impacted by mining. This mitigation plan is for wetland impacts for life of mine, but may be completed only as required by the Nationwide Permit No. 21. Areas planned as reclaimed wetlands and OAR are presented in Exhibit RP.6-1.

RP.9.3 Timing and Nature of Impacts

Table D10.2-1 presents an inventory of all wetlands areas and types within the permit boundary. Table RP.9-1 presents a listing of the wetlands which will be disturbed or removed during the life of mine, and the wetland areas will be potentially impacted by the mining operations.

Impacts to the delineated wetlands will fall within two categories: 1) some wetlands will be physically removed or disturbed by mining activities; 2) other wetlands potentially impacted by reducing or eliminating their contributing drainage areas for temporary time period. Once mining is completed in these areas, the drainage areas will be restored and flow to the wetlands will resume. In such cases, mitigation will consist of flow restoration only with no specific wetland construction required.

RP.9.4 Wetland Mitigation Goals and Postmine Land Use

Wetland mitigation will consist of replacing the postmine wetlands on an "in-kind" basis with their premining counterparts. Several wetland community types will be established at this time. These include permanent impoundments and drainage communities.

During reclamation, individual wetland units will be established following the specific design plans as presented within the following subsections. These areas are expected to remain as permanent elements within the postmine topography. Postmine drainage basin boundaries and postmine hydrologic features are shown on Exhibit RP.8-1.

RP.9.5 Wetland Mitigation Design Plans

Wetland mitigation designs presented herein are based on the basic principle of replacing as many Corps delineated premining features on a one for one "in-kind" basis as possible while still maintaining adequate hydrologic function. The hydrologic parameters focused on during the design of postmine wetlands are frequency, timing and duration of inundation. These parameters are influenced by topographic position, stratigraphy, soil infiltration rates, floodplain configuration (if applicable), type and amount of plant cover, and evapotranspiration rates. Wetland mitigation design primarily focuses on hydrologic function since that is the variable that has the greatest influence over the design of the structure. The sizes of the postmine structures are directly dependent upon the amount of water that is supplied. Therefore, the wetland mitigation structures are sized according to contributing drainage area and configured such that water will be available for plant use for an extended period during the growing season.

The Corps utilizes the January 1987 "Corps of Engineers Wetland Delineation Manual" for the classification of wetlands based primarily on the duration of inundation and/or soil saturation during the growing season. This classification system covers the entire spectrum of inundation possibilities, ranging from permanently inundated to intermittently inundated to never inundated. The postmine wetland mitigation features will be either seasonally or irregularly inundated, similar to what was encountered during premine conditions, as expected due to the semi-arid climate of the Powder River Basin. Although many areas that are irregularly inundated are not classified as wetlands, the proposed postmine wetland features described herein falling under this classification are designed to exhibit adequate hydrologic characteristics to be delineated as wetlands.

The Sheridan area has an average of 101-120 frost-free days, extending from early May through mid-October (WRCC, 1997). Beyond this time frame, hydrophytic vegetation reduces its activity level or enters a dormant stage of growth. To be considered a wetland, the mitigation structure would have to be irregularly inundated or saturated, which is defined as having duration of inundation or saturation of 5 to 12.5 percent of the growing season or more than 5 days per year (Environmental Laboratory, 1987).

The wetland mitigation features will be designed such that the Corps requirement for inundation can be met for each wetland type. Some of the delineated premining wetland features will be affected by mining operations, but not disturbed. For example, their contributing drainage areas may be reduced or the water supply be cut off during mining. Mitigation of such features will be restoration of flow or repair of structures that were compromised. Table RP.9-1 presents the area of wetlands that are impacted but not disturbed or temporarily disturbed, as well as the area that will be physically disturbed by mining. The objective of this plan is to present the approach for wetland mitigation for the entire area that will be disturbed for the life of mine. The approach for the wetland mitigation designs is outlined in the following discussions.

RP.9.5.1 Drainage Wetlands

Replacement drainage wetlands for postmining mitigation occur within the reclaimed sections and/or directly adjacent to channels within the lower reaches of select streams. Stream channel wetlands are predominantly found in the channel bottoms of the larger streams. The drainage wetland features receive sufficient runoff for the development of hydric soils and support selected hydrophytic plant species. The reclamation of these features will occur concurrently with channel reclamation. Postmine channels will have similar gradients, geometry and hydraulic characteristics to the premining channels. Detailed hydrologic and hydraulic designs of the postmining channels are presented in Section RP.8.

RP.9.5.1.1 Hydrologic Budget - Drainage Wetlands

For the main stream channels that flow through the permit area, the postmining drainage areas will be approximately the same as what was present premining. No detailed hydrologic budget has been developed for these postmine stream channels. It is assumed that since wetlands were determined to be present in the premine conditions, these flows are sustained for a period long enough to support wetlands. The postmine channels have been designed to restore the premine hydrologic function by providing a configuration similar to the premine channel. Therefore, flow will be sustained for a period long enough to support wetlands in the postmine environment.

RP.9.5.1.2 Drainage Wetlands Design Procedure

The geometry of the reclaimed drainage channels determines the area available for the development of stream channel wetlands. The designs for the channels are presented in the Section RP.8. It is assumed that periodic saturated conditions will develop on the channel bottoms and up the channel banks to within one vertical foot of the area that is frequently inundated. This will provide the regime to support wetland vegetation.

RP.9.5.2 Impoundment Wetlands and Open Water

Instream pools, depressions, reservoirs and other features include reservoir wetlands and open water. As the Corps indicates, these wetlands are areas that are inundated either permanently or periodically during the growing season with mean water depths of less than 6.6 feet, or where the soil is saturated to the surface for sufficient support of wetland vegetation. These areas are governed by the duration of inundation and are characterized according to the extent of this parameter.

Open water, which is technically defined as deepwater aquatic habitat by the Corps, supports the hydrologic characteristics of surrounding wetlands. These are areas with a mean annual water depth greater than 6.6 feet and will be reestablished within the reservoir boundaries. The Corps has indicated that jurisdictional open waters can have mean annual water depths shallower than 6.6 feet if no vegetation is present.

Reservoir mitigation features proposed for the postmining area include emergent wetland features around the shorelines of postmining reservoirs. The mitigation features are designed to take full advantage of saturated conditions to perpetuate the development and long term existence of wetlands. The permanent postmining impoundments are proposed to provide a "dual purpose" of replacing premining stock reservoirs as well as "in-kind" premining wetland features. Postmining reservoirs were designed to maximize surface area while maintaining depth, slopes and hydrology concurrent with wetland development.

RP.9.5.3 Other Aquatic Resources

Other Aquatic Resources consist of aquatic resources identified which were not wetlands as discussed in Appendix D8. Periodic, short-term flow occurrences characterize these features in the study area. The Corps requires an inventory of OAR; however, there are no mitigation requirements. Therefore, there are no specific mitigation designs included herein. These drainages are intended to replace premining OAR. The postmining drainages exhibit hydraulic and geomorphologic characteristics similar to the premining delineated features. The total acres of Other Aquatic Resources to be replaced as postmining channels are represented in Table RP.9-1.

RP.9.6 Revegetation

The goal of revegetation at the wetland mitigation sites is to create viable hydrophytic zones which provide: 1) surface stability through erosion control, 2) habitat diversity and 3) enhanced habitat values for wildlife.

Selection of plant species for revegetation of the permanent mitigation sites is based on commercial availability, premine species occurrence, expected post-operation hydrologic conditions, substrate properties, establishment potential and postmine land use objectives. Revegetation mixtures used for mitigation sites will be based on a site by site basis with WDEQ approval. In general, bottomland grassland seed mixture presented in Table RP.6-2 will be applied. Seed mixtures may require alterations such as the introduction of grasslike species such as Nebraska sedge depending on site conditions. Species listed in the mixture are usually commercially available; however, alternative species may also be considered if they are available commercially and a dependable water supply is indicated at the time seeding is conducted. Colonization by upstream volunteer hydrophytic species is not uncommon and is expected to occur as well at the wetland mitigation sites.

Cover crops will be used on an as-needed basis for rapid stabilization if necessary, as discussed in Section RP.6.1. Other erosion control devices (jute netting, excelsior blankets, etc.) will also be utilized, if needed.

The permanent wetland mitigation sites will be seeded immediately after seedbed preparation. Seeding of wetland mitigation sites with any alternative species (if used) will only occur after the drainage area contributing to the wetland is completely reclaimed and Brook Mine has received WDEQ approval of the seed mixture.

RP.9.7 Protection and Management

Protection and management parameters include erosion control, revegetation success, noxious weed control, effects of livestock grazing and wildlife management. Specifically:

- Damage to the reclaimed surface from erosion will be repaired on a site by site basis by regrading, reestablishing vegetation and utilizing ASCMs, as necessary.
- Results of revegetation and soil monitoring will be assessed to determine the need for corrective measures such as supplemental seeding or planting, reseeding, or supplemental fertilization.
- Weed populations will be evaluated regularly to assess the need for control efforts.
- Livestock grazing will be manipulated to discourage concentration in these areas. This will be accomplished using exclusion fencing, supplemental watering devices, distribution of salt away from bottomlands and creative grazing systems designed to prevent concentration in bottomlands.
- Wildlife will be allowed to utilize these sites unless it is determined that unacceptable damage is occurring. Movement across these areas will be encouraged through the use of appropriately constructed fences conforming to WDEQ/LQD Guideline Number 10.

RP.9.8 Monitoring

The following monitoring plan will be implemented during both the interim and bond release phases of monitoring reclaimed wetlands. Wetland monitoring procedures will follow Section E "Comprehensive Determinations" and Section F "Atypical Situations" of the 1987 Technical Report Y-87-1 Corps of Engineers Wetlands Delineation Manual by Environmental Laboratory. For sampling purposes, all wetlands established in a specific reservoir will be considered one reservoir wetland unit. Stream channel wetlands will be combined into an integrated series of units based on the time flow is restored to a section of a creek.

Monitoring will be initiated once an area has been seeded and water is made available for at least two years in amounts providing sufficient depth and period of inundation to support the development of wetland plant species.

Other Aquatic Resources will be shown on postmine maps; however, no specific monitoring will be conducted.

Photographs of each reclaimed wetland and/or open water area will be taken from established locations during the growing season. These photo locations and directions will be included on the map of wetland features included in the Annual Reports after the wetland sites are constructed.

Section E was used even though the Corps manual only recommends using the comprehensive determination methods when the project area is very complex and the determination requires rigorous documentation (Section E, Paragraph 67). The applicable monitoring steps in Section E of the Corps manual are as follows:

RP.9.8.1 Vegetation

Paragraph 70, Step 1 identifies the project area, and Step 2 determines whether an atypical situation exists. These steps will not likely be required during the postmine monitoring because the areas are already well known. Paragraph 70, Step 3 requires a determination of the homogeneity of vegetation for use in determining the number and locations of monitoring points. With the use of a standard seed mix, vegetation communities are expected to be similar. Paragraph 70, Step 4 procedures will be limited to describing the herbaceous understory layer of the community.

Paragraph 70, Step 5 requires a determination whether normal environmental conditions are present. Although normal circumstances will not be present for the first several years, or until proper site conditions have been established and settled, initial monitoring must still be done with the conclusion that normal environmental conditions are yet to be present. In some years, hydrophytic vegetation and/or hydrologic indicators may be lacking as a result of annual or seasonal fluctuations in precipitation or groundwater levels, and seasonal fluctuations in temperature. As described in Section G, Paragraph 78, seasonal wetlands, especially in the western states, may have wetland indicators during the wetter portion of the growing season, but lack of hydrologic wetland indicators and/or vegetation during the drier portion of the growing season. Precipitation, surface flow, and temperature monitoring results, combined with field observations, will be used to determine if abnormal conditions have occurred.

Paragraph 70, Steps 6 through 8 will be used to determine the location and number of required transects, and the number of observation points required along each transect. The tables presented in Steps 7 and 8 provide recommended spacing and observation point densities. A minimum of one permanent transect will be established in each wetland unit or integrated series of units.

Paragraph 70, Step 9 outlines procedures for characterizing the herbaceous cover and recommends using one square meter quadrats along the transects. Percent cover of each plant species with foliage extending into the quadrat will be estimated.

Paragraph 70, Step 13 procedures will be followed for determining whether hydrophytic vegetation is present. With only a herbaceous layer expected, a maximum of five dominant species will be used to determine if wetland species are present. If more than 50 percent of the dominant plant species are obligate wetland, facultative wetland and/or facultative plants, then the area has met the hydrophytic vegetation criteria for a wetland. If the 50 percent criterion is not met, then Step 13(b) will be implemented. If two or more dominant species have observed morphological adaptations or known physiological adaptations for occurrence in wetlands, then hydrophytic vegetation is present. Hydrophytic vegetation cover must be documented in the monitoring reports.

RP.9.8.2 Hydric Soils Determination

Paragraph 70, Step 14 addresses the determination of hydric soils. However, with reclaimed wetlands falling under the category of man-induced wetlands, soil characterization is not applicable. As described in Paragraph 76, Subsection 4, a man-induced wetland is one that has developed at least some characteristics of naturally occurring wetlands due to either intentional or incidental human activities.

COE examples of man-induced wetlands include wetlands resulting from impoundments (reservoir shorelines) and wetlands resulting from stream channel realignment. In addition, Subsection 4 states that indicators of hydric soils are usually absent in man-induced wetlands. As stated therein, hydric soils require hundreds of years for development of hydric characteristics.

the mine will establish one permanent soil monitoring station in each wetland unit, or integrated series of units for stream channel wetlands. Each station will consist of a hand shovel pit or auger point. Each station will be observed at representative locations within the mitigation area during the third and fifth year following establishment of hydrologic conditions sufficient to support wetlands. The presence of absence of hydric soil indicators will be discussed in the monitoring reports.

RP.9.8.3 Hydrology

Paragraph 70, Step 12 references Part III, Paragraph 49 of the "Wetlands Delineation Manual" for determining indicators of wetland hydrology. As stated in Paragraph 49, indicators of wetland hydrology may include:

- Drainage patterns,
- Drift lines,
- Sediment deposition,
- Watermarks,
- Stream gauge data and flood predictions,

- Historic records,
- Visual observation of saturated soils, and
- Visual observation of inundation.

Paragraph 48 indicated that the duration of inundation and/or soil saturation during the growing season has more influence on the plant community than the frequency of inundation and saturation during the growing season. Hydrology determinations are also discussed under Section F, “Atypical Situations” Subsection 3. Procedures described to determine whether wetland hydrology previously occurred are not necessary. Baseline and life-of-mine hydrology monitoring programs, and the premining wetlands delineation in Appendix D10, indicate that sufficient wetland hydrology was available in limited areas.

Monitoring wetlands hydrology on reclaimed lands will consist primarily of:

- Postmine surface water monitoring stations and/or staff gauges,
- Field observations of periods of inundation, and
- Field observations of saturated soils.

One or more staff gauges will be placed in each wetland unit, or integrated series of units. The wetland unit will be surveyed and the staff gauges will be marked to identify the minimum depth of water necessary to inundate the wetland. The gauges will be monitored twice per week during periods when flow is sufficient to inundate the areas. This will generally occur between May 1 and September 30 during periods of runoff-producing rainfall events. Once inundation has been documented for a minimum of eight days for permanent impoundments, the monitoring frequency will be reduced to biweekly visits.

Data collection from surface water monitoring sites constructed as part of the postmine hydrologic monitoring program will be used to monitor the stage heights within the integrated units of stream channel wetlands. At least one additional staff gauge will be established near the midpoint of each integrated series of stream channel wetland units.

RP.9.8.4 Sampling Schedule

The COE requires three to five years of monitoring to determine if wetlands were adequately established. The mine will initiate monitoring during the third growing season following establishment of surface water flow to ensure adequate time for wetland vegetation to establish. Monitoring will occur again in the fifth year. If hydrophytic vegetation has established sufficiently to consider the community a wetland, then vegetation monitoring will be suspended until bond release. If a wetland unit or series of units does not meet the wetland standards, monitoring will continue on two-year intervals until the standards are met. The mine will collect five consecutive years of monitoring data prior to submitting each final bond release submittal. Once hydrophytic vegetation is established, wetland hydrology becomes the key parameter. Therefore, the mine will continue to collect surface hydrology data using the methods discussed in Section RP.8.5.2 through bond release.

All wetlands monitoring data will be compared to the approved reclamation and mitigation plans, and will be submitted in the appropriate Annual Report.

RP.10 REESTABLISHMENT OF ESSENTIAL HYDROLOGIC FUNCTIONS AND AGRICULTURAL UTILITY ON ALLUVIAL VALLEY FLOORS

At this time, the mine does not plan any direct mining to occur on areas that have been identified as possible Alluvial Valley Floors (AVF) and only minor disturbance to the Big Horn Mine AVF extent within Section 21 of Township 57 North, Range 84 West is anticipated. AVF material will be reclaimed to mimic premine conditions and allow continued conveyance of flow. Very minor impacts to the Tongue River and Goose Creek AVFs are expected as discussed. Therefore, the essential hydrologic functions of the AVFs in Goose Creek and the Tongue River valleys as described in Appendix D11 shall be maintained. AVF areas disturbed by mining operations will be very minor and will continue to allow conveyance of flow throughout the Tongue River AVF. Infrared aerial photography of the area will be obtained every five years and photo documentation annually and analyzed to determine the state of the essential hydraulic functions of the Slater Creek, Goose Creek, and Tongue River AVFs. In addition, alluvial wells in Slater Creek, the Tongue River, and Goose Creek will be monitored to ensure the essential hydrologic functions will be maintained. The wells will be monitored in accordance with Guidelines 8 and 9 and any applicable WDEQ/LQD R&R during mining and reclamation. The well locations are displayed on Exhibit RP.8-5 and listed on Table RP.8-7. In addition, surface water monitoring will continue as described in Section RP.8.4.2.

RP.11 RECLAMATION OF MINE FACILITIES, ROAD, AND RAILROADS

RP.11.1 Facilities and Utilities

Following the completion of mining activities, and assuming that no future mining or mineral recovery is planned, all buildings, facilities, and equipment will be decommissioned and removed from the site.

Equipment, surplus materials, and fuel and water tanks will be removed and disposed of off-site, and/or recycled in accordance with applicable regulations. Pipelines, power lines, culverts, building foundations, and building pads will be removed in accordance with applicable regulations. Debris may be buried on-site as allowable by closure guidelines and regulatory approval at the time of closure.

Scrap material, refuse, unwanted equipment, and surplus materials will be removed and disposed at an appropriate landfill site. Any closed waste management units and/or sewage facilities will be cleaned and all hazards will be remediated in accordance with applicable rules and regulations. Any sedimentation ponds and/or waste ponds will be closed in accordance with applicable rules and regulations.

RP.11.2 Roads

In general, all primary and ancillary roads will be removed unless roads are retained as an approved postmining land use.

Reclamation of roads not being retained will be accomplished by closing the road to traffic, ripping and removal of surfacing materials and grading roadbeds to contours consistent with approved PMT to complement the drainage pattern of the surrounding landscape. Topsoil will be replaced and revegetation will occur as described in preceding Sections RP.5 and RP.6, respectively.

All water control structures, including ditches, bridges, and culverts, that are not retained will be removed or buried in place as approved. Natural drainage patterns will be protected through appropriate control measures as necessary.

RP.11.3 Railroads

No railroads are planned for construction at the Brook Mine at this time.

RP.12 RECLAMATION AND BONDING OF DUAL PERMITTED AND LICENSE TO MINE AREAS

The permit area for Taylor Quarry of Taylor Investments, LLC (Taylor) lies within the proposed permit area of Brook Mine as shown on Exhibit RP.2-1. Additionally, reclaimed portions of the Big Horn Coal Mine's (Big Horn Coal) permit boundary are within the Brook Mine permit boundary, as shown on Exhibit RP.2-1.

Each separate party will bond all areas disturbed by their mining activities. Once a second party enters an area, bonding responsibility on all lands they plan to disturb during the appropriate bonding period will be transferred. The last party to disturb an area will have final reclamation responsibility on the disturbed dual permitted lands.

Where lands are located within each mine's permit boundary, all mining operations are covered by a License to Mine under the individual Permits to Mine. Activities conducted within Taylor Quarry's Permit Area are conducted under a License to Mine under Taylor Quarry Permit No. SP0757. Activities conducted by Big Horn Coal are under Big Horn Coal's Permit No. 213-T8.

RP.13 RECLAMATION SCHEDULE

The permit term for the Brook Mine will occur over a 43-year period while mining activities will occur over a 39-year period beginning in 2020 (corresponds to Year 1 in all Exhibits, Figures and text) as discussed in Section

MP.1.6 of the Mine Plan. Any changes in reclamation schedule will be reflected in the annual report of the corresponding year. Reclamation will occur concurrently with mining activities.

Monitoring of reclamation efforts will occur according to the monitoring plan approved by WDEQ/LQD. Monitoring stations used during normal mining operations will continue to be monitored post mine closure as directed by WDEQ/LQD. Monitoring will continue following closure and reclamation until suitable conditions concerning water quality and revegetation uptake have been reached.

RP.14 BOND RELEASE

Bond release for the Brook Mine will follow the procedures outlined in the WDEQ/LQD R&R Chapter 15 and WDEQ/LQD Guidelines No. 20, 21, 22, 23 and 25. Incremental bond release will be requested as reclamation proceeds in accordance with the approved reclamation plan and requirements of WDEQ/LQD R&R Chapter 15 and Chapter 4.

RP.15 UNDERGROUND MINES

No underground mining is planned at the Brook Mine at this time.

RP.16 RECLAMATION COSTS

Reclamation cost estimates to decommission the Brook Mine and reclaim the disturbed areas will be prepared annually in accordance with WDEQ/LQD Guideline Number 12 (Guideline 12) "Standardized Reclamation Performance Bond Format and Cost Calculation Methods." The reclamation cost estimates will be included in the Annual Report and will be adjusted annually.

RP.17 REFERENCES

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Table RP.3-1. Comparison of Brook Mine Premining and Postmining Slopes

	Premining	**Postmining**
Average Slope:	13.50%	13.40%
Minimum Slope:	0.00%	0.00%
Maximum Slope:	69.50%	69.50%

Table RP.6-1. Comparison of Brook Mine Total Affected Area of Premining Vegetation Community and Postmining Vegetation Community

<table>
<tr><th colspan="3">Premining</th><th colspan="3">Postmining</th></tr>
<tr><th>Vegetation Community</th><th>Total Acres</th><th>Disturbed Area (%)</th><th>Vegetation Community</th><th>Total Acres</th><th>Disturbed Area (%)</th></tr>
<tr><td>Agricultural Land</td><td>3.1</td><td>0.3</td><td>Hayland</td><td>3.9</td><td>0.3</td></tr>
<tr><td>Big Sagebrush Shrubland</td><td>223.1</td><td>19.7</td><td rowspan="2">Shrubland</td><td rowspan="2">358.1</td><td rowspan="2">31.5</td></tr>
<tr><td>Rough Breaks Mixed Shrubland</td><td>120.9</td><td>10.7</td></tr>
<tr><td>Bottomland Sagebrush Grassland</td><td>19.8</td><td>1.7</td><td rowspan="2">Bottomland Grassland</td><td rowspan="2">26.6</td><td rowspan="2">2.3</td></tr>
<tr><td>Riparian Woodland</td><td>7.2</td><td>0.6</td></tr>
<tr><td>Pine and Juniper Woodland</td><td>8.0</td><td>0.7</td><td rowspan="5">Upland Grassland</td><td rowspan="5">679.5</td><td rowspan="5">59.9</td></tr>
<tr><td>Prairie Dog Modified Grassland</td><td>119.0</td><td>10.5</td></tr>
<tr><td>Reclaimed Grassland</td><td>241.7</td><td>21.3</td></tr>
<tr><td>Scoria Grassland</td><td>133.1</td><td>11.7</td></tr>
<tr><td>Upland Grassland</td><td>164.4</td><td>14.5</td></tr>
<tr><td>Disturbance</td><td>83.6</td><td>7.4</td><td>Disturbance</td><td>51.0</td><td>4.5</td></tr>
<tr><td>Water</td><td>1.0</td><td>0.1</td><td>Water</td><td>5.8</td><td>0.5</td></tr>
<tr><td>Wetlands & Other Aquatic Resources</td><td>10.2</td><td>0.9</td><td>Wetlands & Other Aquatic Resources</td><td>10.2</td><td>0.9</td></tr>
<tr><td>Total</td><td>1135.1</td><td>100.0</td><td>Total</td><td>1135.1</td><td>100.0</td></tr>
</table>

Notes: [1] Water, Riparian Woodlands, and Bottomland Sagebrush Grassland communtities appear small because the Wetland and Other Aquatic Resource community intersects these communities.

[2] The premining disturbance vegetation community consists of roadways, railroads, quarrys, etc. The disturbance postmining vegetation community includes any postmine roadways and railroads.

Table RP.6-2. Postmining Seed Mixtures by Vegetative Community for Brook Mine[2]

Life Form / Species	Seed Mixture by Postmine Vegatative Community (PLS/ac)[1]				
	Interim	Upland Grassland	Bottomland Grassland	Shrubland	Hayland
Perennial Cool Season Grasses					
Western Wheatgrass	4.0	4.0	4.0	1.0	
Thickspike Wheatgrass	4.0	4.0	4.0		
Slender Wheatgrass	4.0	3.0	3.0		1.0
Sandberg Bluegrass		0.5	0.5	0.3	
Green Needlegrass		3.0	3.0	0.5	
Needle-and-thread				1.0	
Bluebunch Wheatgrass	4.0	3.0		2.0	
Smooth Brome					1.0
Prairie junegrass				0.1	
Crested Wheatgrass					1.5
Perennial Warm Season Grasses					
Blue Grama		0.5	0.5	2.0	
Buffalo grass				2.0	
Prairie Cordgrass			0.5		
Canada wildrye			0.5		
Perennial Forbs					
American Vetch			1.0	0.3	
Common Sainfoin		2.0	2.0		
Purple Prairie Clover		1.0			
Western Yarrow				0.3	
Lewis Flax				0.3	
Prairie Coneflower			0.5		
Scarlet globemallow				0.3	
Alfalfa					4.0

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Table RP.6-2. Postmining Seed Mixtures by Vegetative Community for Brook Mine (continued)[2]

Life Form / Species	Seed Mixture by Postmine Vegatative Community (PLS/ac)[1]				
	Interim	**Upland Grassland**	**Bottomland Grassland**	**Shrubland**	**Hayland**
Subshrubs					
Winterfat		1.0	0.5	2.0	
Fringed Sagewort		0.5		0.1	
Garner saltbush				0.5	
Shrubs					
Big Sagebrush		1.0		4.0	
Silver Sagebrush			0.5	2.0	
Fourwing saltbrush		0.5		0.5	
Rubber Rabbitbrush		0.5		0.3	
Yellow Rabbitbrush				0.3	
Western Snowberry			0.5	0.5	
Wood's Rose			0.5	2.0	
Skunkbush Sumac		0.5		2.0	
Total Pounds PLS/Acre	16.0	25.0	21.5	24.2	7.5

Notes: [1] Pounds pure live seed/acre (PLS/acre) based on application rate when drilled, application rate is doubled when broadcasted.

[2] Seed mixtures developed in accordance with WDEQ/LQD Guideline 2.

Table RP.6-3. Brook Mine Shrub Density Standard Option II Premine Information

Vegetation Community	Number of Affected Acres Following Rule Approval	Percent Eligible Acres	Premining Total Shrub Density per m^2	Premining Total Shrub Number[2]
Agricultural Lands[1]	3.1	N/A	N/A	N/A
Big Sagebrush Shrubland	223.3	21.4	0.9	796,679
Bottomland Sagebrush Grassland	21.5	2.1	0.3	21,855
Pine and Juniper Woodland	8.0	0.8	0.2	6,583
Prairie Dog Modified Grassland	119.0	11.4	0.1	30,170
Reclaimed Grassland	242.6	23.3	0.1	52,772
Riparian Woodland	8.3	0.8	2.6	85,742
Rough Breaks Mixed Shrubland	120.9	11.6	1.1	520,457
Scoria Grassland	133.1	12.8	0.3	161,166
Upland Grassland	164.8	15.8	0.1	68,162
Disturbance[1]	83.8	N/A	N/A	N/A
Water[1]	6.7	N/A	N/A	N/A
Total Eligible Acreage	1041.5		**Premining No. of Shrubs**	1,743,586
Total Acreage	1135.1			
% Eligible/Total	91.8			

Notes: [1] Lands identified as non-eligible because shrub density was not sampled due to lack of shrubs.

[2] Premining shrub number calculated from Appendix D8 raw data for shrub density/acre.

Table RP.6-4. Brook Mine Shrub Density Standard Option II Postmine Shrub Replacement Information

Relative Premining Density for Primary Shrubs (≥10% Relative Density)		Postmining Total Shrub Density m² D*	N	D x (1/N+1) Density of Dominant per m²	Density of Residual Shrubs per m²	Density of Residual Subshrubs per m²	20% Acreage Reclaimed with Shrubs	Number of Shrubs Established
Big Sagebrush	**Four-wing saltbrush**							
0.46	**0.21**	← Numbers are weighted average relative density from Table RP.6-5						
	Reduced Permit-wide Standard							
	100% at 1/m²	**1.00**	**2**	**0.33**	**0.33**	**0.33**	**208**	**842,990**
		Dominant Species for this Option: Big Sagebrush						
					20 percent of eligible lands		**208**	
* D =Postmining Total Shrub Density (e.g. 1.0 x [1/(2+1)] = 0.33)					**Postmining No. of Shrubs**			**842,990**

Table RP.6-5. Brook Mine Shrub Density Standard Option II Relative Density Information By Species

Species	Big Sagebrush Shrubland	Bottomland Sagebrush Grassland	Pine and Juniper Woodland	Prairie Dog Modified Grassland	Reclaimed Grassland	Riparian Woodland	Rough Breaks Mixed Shrubland	Scoria Grassland	Upland Grassland	Weighted Average Relative Density [3]
Silver sagebrush	0.01	0.65		0.01	0.09	0.11	0.02	0.09	0.14	0.07
Big sagebrush	0.96		0.40	0.31	0.02	0.00	0.59	0.61	0.42	0.46
Four-wing saltbush					0.89		0.00			0.21
Yellow rabbitbrush	0.02		0.06	0.37			0.00	0.01	0.15	0.07
Rubber rabbitbrush	0.01		0.16	0.27	0.00	0.00	0.18	0.03	0.06	0.07
Skunkbrush sumac	0.00	0.01	0.16	0.00		0.00	0.01	0.21	0.04	0.04
Wax currant	0.00		0.09			0.00		0.00	0.01	0.00
Woods rose		0.00	0.13			0.01	0.17	0.05	0.03	0.03
Greasewood							0.03		0.03	0.01
Russet buffaloberry						0.00				0.00
Common snowberry	0.00	0.00		0.04		0.86	0.00	0.00	0.12	0.03
Western snowberry		0.34				0.02	0.00	0.00		0.01
Snowberry		0.00								0.00
Full Shrub Total	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
All Full Shrubs/m^2[2]	0.9	0.3	0.2	0.1	0.1	2.6	1.1	0.3	0.1	

Notes: [1] Dominant Full Shrub Species for each eligible community is shaded.

[2] Subshrubs excluded from shrub density.

[3] Calculated by summing across communities the individual species times the percent eligible acreage of each community divided by 100.

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Table RP.6-6. Brook Mine Extended Reference Areas of Vegetation Communities

Brook Mine Permit Area		Disturbed Acreage		Extended Reference Area (Acres)
Vegetation Community	**Acres**	**Vegetation Community**	**Total Acres**	
Agricultural Land	4.5	Hayland	3.9	0.6
Big Sagebrush Shrubland	913.7	Shrubland	358.1	1131.6
Rough Breaks Mixed Shrubland	576.0			
Bottomland Sagebrush Grassland	50.6	Bottomland Grassland	26.6	81.2
Riparian Woodland	57.2			
Pine and Juniper Woodland	67.7	Upland Grassland	679.5	2144.8
Prairie Dog Modified Grassland	436.7			
Reclaimed Grassland	596.7			
Scoria Grassland	726.0			
Upland Grassland	995.9			
Rabbitbrush Shrubland	1.3			
Disturbance	109.7	Disturbance	51.0	58.7
Water	12.8	Water	5.8	5.8
		Wetlands & Other Aquatic Resources	10.2	N/A
Total	4548.8	**Total**	1135.1	3422.65

Table RP.8-1. Postmining Drainage Basin Characteristics

Drainage Basin Designation	Watershed Area (ac)	Basin Length (mi)	Valley Length (mi)	Channel Length (mi)	Basin Relief (ft)	Valley Relief (ft)	Channel Relief (ft)	Total Stream Length (mi)	Basin Relief Ratio (ft/ft)	Valley Slope (ft/mi)	Channel Slope (ft/mi)	Channel Sinuosity	Drainage Density (mi/mi^2)	Curve No.
TR1	154.6	0.76	0.71	0.73	300	160	160	0.73	0.07	226	221	1.02	3.00	74
TR2	334.5	1.41	1.48	1.59	460	270	270	1.59	0.06	183	169	1.08	3.05	72
TRD1	19.9	0.38	0.31	0.31	260	210	210	0.31	0.13	675	672	1.01	7.97	72
TRD2	328.2	1.50	1.34	1.44	435	285	285	1.44	0.05	206	191	1.08	2.81	74
TRD3	378.6	1.61	1.66	1.79	445	375	375	2.29	0.05	227	212	1.07	3.84	71
TRD4	172.8	0.91	0.46	0.50	230	80	80	0.50	0.05	173	160	1.08	1.85	82
TRD5	595.6	1.73	1.56	1.64	300	200	200	2.86	0.03	128	122	1.05	3.08	83
SLATER CREEK	10522.6	10.60	10.63	14.20	1600	1100	1100	54.73	0.03	103	77	1.34	3.33	79
SCSUB1	270.6	1.20	1.20	1.24	375	265	265	1.75	0.06	222	215	1.03	4.11	76
SCSUB2	259.2	0.95	0.83	0.86	405	185	185	1.35	0.08	223	215	1.04	3.34	75
SCSUB3	198.8	0.98	0.91	0.95	300	230	230	0.95	0.06	252	242	1.04	3.06	76
SCSUB4	219.5	0.85	0.86	0.92	205	115	115	1.60	0.05	134	125	1.07	4.65	84
SCSUB5	86.5	0.62	0.62	0.62	290	170	170	0.62	0.09	289	289	1.00	4.91	75
EFEC	1178.1	3.63	3.40	3.82	520	310	310	4.81	0.03	91	81	1.12	2.61	87
HIDDEN WATER CREEK	5113.2	6.27	7.04	7.80	885	805	805	25.03	0.03	114	103	1.11	3.14	76
HWCSUB1	120.6	0.68	0.52	0.53	220	130	130	0.53	0.06	257	251	1.02	2.75	76
HWCSUB2	91	0.58	0.31	0.33	190	115	115	0.33	0.06	368	352	1.04	2.30	77
HWCSUB3	46.4	0.71	0.54	0.56	260	200	200	0.56	0.07	373	360	1.03	7.66	76
HWCSUB4	112	0.95	0.71	0.72	380	250	250	0.72	0.08	353	345	1.02	4.14	75
HWCSUB5	76.2	0.62	0.59	0.60	340	230	230	0.60	0.10	391	382	1.02	5.06	76
GC1	219.3	1.17	0.83	1.07	220	120	120	1.07	0.04	144	112	1.28	3.12	81

Note: Drainage basin characteristics are based on modeled postmine topography.

Table RP.8-2. Postmine HEC-HMS Peak Flow and Runoff Volumes for the 6-Hour Events

Stream Designation	Storm Event Recurrence Interval (yr)[1]											
	2		5		10		25		50		100	
	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)
GC1	21.1	4.6	39.2	8.7	52.9	11.8	71.1	16.0	85.4	19.4	100.1	22.9
HWC (HWC Out)	229.5	85.2	442.3	165.0	607.2	227.7	831.4	313.8	1011.2	383.6	1199.1	457.2
HWC Sub 1	15.1	2.0	28.9	4.0	39.6	5.5	54.0	7.5	65.5	9.2	77.5	11.0
HWC Sub 2	13.4	1.6	25.4	3.0	34.7	4.2	47.1	5.7	57.0	7.0	67.4	8.3
HWC Sub 3	5.7	0.8	11.0	1.5	15.0	2.0	20.4	2.8	24.8	3.4	29.3	4.0
HWC Sub 4	11.8	1.9	22.6	3.6	31.0	5.0	42.4	6.9	51.6	8.5	61.1	10.1
HWC Sub 5	11.5	1.3	21.9	2.5	30.0	3.5	40.8	4.8	49.5	5.8	58.6	6.9
TR Sub 1	31.5	5.1	60.7	10.0	83.4	13.9	114.4	19.3	139.3	23.6	165.4	28.2
TR Sub 2	8.7	2.2	17.0	4.3	23.5	6.0	32.4	8.3	39.6	10.2	47.2	12.3
SC1 (SC Out)	499.9	198.8	950.6	380.2	1295.7	521.0	1760.4	712.7	2130.4	866.9	2514.9	1028.3
SC Sub 1	23.8	4.5	45.6	8.8	62.4	12.1	85.1	16.6	103.3	20.3	122.2	24.2
SC Sub 2	28.9	4.2	55.4	8.2	75.9	11.4	103.9	15.7	126.3	19.2	149.6	23.0
SC Sub 3	19.3	3.3	36.9	6.5	50.5	8.9	68.8	12.3	83.5	15.0	98.8	17.9
SC Sub 4	29.7	5.3	54.2	9.8	72.2	13.3	95.8	17.9	114.2	21.5	132.9	25.3
SC Sub 5	10.4	1.4	20.0	2.8	27.5	3.9	37.6	5.4	45.7	6.6	54.1	7.8
EF EC	95.7	33.3	171.0	60.7	225.6	80.9	296.5	107.6	351.3	128.6	407.1	150.1
TRD 1	2.8	0.3	5.4	0.5	7.5	0.7	10.3	1.0	12.6	1.3	15.0	1.5
TRD 2	20.3	5.0	39.2	9.8	53.9	13.6	74.0	18.9	90.2	23.2	107.1	27.7
TRD 3	19.9	5.2	38.9	10.2	53.9	14.2	74.5	19.8	91.2	24.4	108.8	29.2
TRD 4	22.9	3.8	42.4	7.2	56.9	9.7	76.1	13.2	91.1	15.9	106.6	18.8
TRD 5	58.8	13.7	108.0	25.7	144.7	34.8	192.9	47.0	230.7	56.7	269.4	66.7

Note: [1] Storm events are SCS Type II, 6-hr General Storms.

Table RP.8-3. Postmine HEC-HMS Peak Flow and Runoff Volumes for the 24-Hour Events

Stream Designation	Storm Event Recurrence Interval (yr)[1]											
	2		5		10		25		50		100	
	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)	Peak (cfs)	Vol. (Ac-ft)
GC1	48	11	77	17	99	21	131	28	157	34	184	39
HWC (HWC Out)	475	206	773	331	1006	427	1352	570	1636	686	1931	807
HWC Sub 1	37	5	59	8	77	10	104	14	125	16	148	19
HWC Sub 2	33	4	53	6	69	8	92	10	111	12	131	15
HWC Sub 3	14	2	23	3	29	4	39	5	48	6	56	7
HWC Sub 4	28	5	46	7	60	9	80	13	98	15	115	18
HWC Sub 5	28	3	46	5	60	6	80	9	97	10	115	12
TR Sub 1	75	12	123	20	161	26	217	35	264	42	312	50
TR Sub 2	20	5	33	9	43	11	58	15	71	19	84	22
SC1 (SC Out)	1022	473	1637	750	2113	963	2812	1275	3380	1528	3968	1789
SC Sub 1	56	11	91	17	118	23	159	30	192	36	227	42
SC Sub 2	69	10	113	16	148	21	199	28	241	34	285	40
SC Sub 3	46	8	74	13	97	17	130	22	157	27	186	31
SC Sub 4	69	12	108	19	138	24	181	31	215	36	250	42
SC Sub 5	25	4	41	6	54	7	72	10	87	12	103	14
EF EC	194	74	298	112	376	141	486	182	574	214	663	247
TRD 1	7	1	12	1	15	1	21	2	25	2	30	3
TRD 2	46	12	76	20	99	26	133	34	162	42	192	49
TRD 3	45	13	74	21	98	27	133	36	162	44	193	52
TRD 4	54	9	85	14	110	18	145	23	173	27	202	32
TRD 5	133	32	210	49	269	62	353	81	421	97	490	113

Note: [1] Storm events are SCS Type II, 24-hr General Storms.

Table RP.8-4. Postmine Peak Flow Estimates Comparison

Basin	Method	Parameter (unit)	Recurrence Interval (yr)					
			2	5	10	25	50	100
Hidden Water Creek	HEC-HMS	Peak Flow (cfs)	475	773	1006	1352	1636	1931
	Miller (2003)	Peak Flow (cfs)	80	208	339	560	766	1014
Slater Creek	HEC-HMS	Peak Flow (cfs)	1015	1626	2099	2794	3359	3944
	Miller (2003)	Peak Flow (cfs)	113	289	468	769	1048	1383

Table RP.8-5. Postmine HEC-RAS Modeling Results

Channel	Storm Event	Average Channel Hydraulic Properties					
		Flow Depth (ft)	Channel Top Width (ft)	Flow Area (ft^2)	Manning's "n"	Hydraulic Radius (ft)	Channel Velocity (ft/s)
Hidden Water Creek	2-Year, 24-Hour	2.15	94.9	149.9	0.028	1.24	5.47
	100-Year, 24-Hour	3.81	145.8	353.3	0.026	2.19	7.83
Slater Creek	2-Year, 24-Hour	2.10	186.3	190.4	0.027	1.16	5.80
	100-Year, 24-Hour	3.75	292.6	540.6	0.026	2.09	8.26

Table RP.8-6. Permanent Impoundment Design Features

Impoundment Designation[1,5]	Drainage Area (sq mi)	Mean Annual Flow[2] (ac-ft)	Impound Capacity[3] (ac-ft)	Surface Area at the High Water Line (acres)	Approximate Year to be Constructed[4]
Replacement Stockpond 1	0.033	1.57	6.40	1.2	Years 7-11 of mining
Enhancement Stockpond 1	0.023	1.23	29.05	3.6	Years 7-11 of mining

Notes: [1] The locations of all permanent impoundments are shown on Exhibit RP.3-1.

[2] Mean annual flow estimates are based on Hadley and Schumm, 1961.

[3] Impoundment sizes are conceptual ; detailed designs will be submitted during the permit term of construction

[4] Approximate year to be constructed was estimated from Exhibit RP.5-1.

[5] Table only includes stockponds added to postmine surface. All premine stockponds removed will be reclaimed to premine conditions.

Table RP.8-7. Postmining Groundwater Monitoring Program

Well Number	Location					Ground Surface Elevation (ft)	Measuring Point Elevation (ft)	Height (ft)	Depths (ft)			Geologic Formation	Casing Diameter (in)	Drill Bit Diameter (in)	Date Completed
	SEC	T(N)	R(W)	Ground Coordinates					Total[2]	Casing	Perforation Interval				
				Northing	Easting										
578415-CRN-MST	15	57	84	1,936,078	1,404,292	3,611.4	3,614.3	2.9	182	121	121-141	Carney and Masters Coal	5	9.875	9-Oct-13
578418-AL	18	57	84	1,935,962	1,386,058	3,687.5	3,690.2	2.7	27	5	5-25	Alluvium	5	9.875	30-Sep-13
578418-CRN	18	57	84	1,936,928	1,387,102	3,882.4	3,884.5	2.1	153	132	132-152	Carney Coal	5	9.875	19-Sep-13
578418-MST	18	57	84	1,936,923	1,387,131	3,883.6	3,885.8	2.2	183	176	176-182	Masters Coal	5	9.875	16-Sep-13
578510-CRN	10	57	85	1,941,542	1,371,807	3,962.4	3,965.4	3	91	78	78-90	Carney Coal	5	9.875	24-Sep-13
578510-MST	10	57	85	1,941,558	1,371,823	3,962.4	3,964.4	2	146	141	141-146	Masters Coal	5	9.875	24-Sep-13
578511-CRN	11	57	85	1,940,246	1,377,926	3,893.8	3,896.1	2.3	128	119	119-127	Carney Coal	5	9.875	23-Sep-13
578511-MST	11	57	85	1,940,244	1,377,945	3,894.0	3,896.4	2.4	157	152	152-157	Masters Coal	5	9.875	23-Sep-13
578512-AL	12	57	85	1,940,880	1,381,530	3,758.0	3,760.5	2.5	22	5	5-20	Alluvium	5	9.875	25-Sep-13
578512-CRN	12	57	85	1,943,160	1,382,758	3,931.0	3,932.5	1.5	62	35	35-55	Carney Burn	5	9.875	20-Sep-13
578512-MST	12	57	85	1,943,172	1,382,743	3,930.9	3,932.7	1.8	114	109	109-114	Masters Coal	5	9.875	20-Sep-13
578513-AL	13	57	85	1,938,634	1,383,970	3,721.9	3,724.0	2.1	22	5	5-20	Alluvium	5	9.875	30-Sep-13
578513-CRN	13	57	85	1,938,329	1,381,665	3,847.7	3,850.0	2.3	116	107	107-115	Carney Coal	5	9.875	25-Sep-13
578513-MST	13	57	85	1,938,341	1,381,680	3,848.4	3,850.6	2.2	142	137	137-142	Masters Coal	5	9.875	25-Sep-13
578417-MST[4]	17	57	84	1,939,175	1,391,382	3,925.9	3,928.7	2.8	163	156	156-161	Masters Coal	2	5.125	21-Aug-13
578417-CRN[4]	17	57	84	1,939,152	1,391,364	3,926.4	3,929.1	2.7	140	118	118-140	Carney Coal	2	5.625	21-Aug-13
578408-MST[5]	8	57	84	1,941,802	1,394,423	3,887.9	3,890.5	2.6	118	113	113-118	Masters Coal	2	5.125	3-Sep-13
578408-CRN[5]	8	57	84	1,941,810	1,394,416	3,887.7	3,890.0	2.3	124	86	86-96	Carney Coal	2	5.125	3-Sep-13
578433-AL-1	33	57	84	1,922,971	1,401,543	-	3,636.1	-	16.0	0.0	6-16	Alluvium	2	5.125	14-Aug-15
578434-AL-1	34	57	84	1,921,606	1,403,638	-	3,645.6	-	13.0	0.0	3-13	Alluvium	2	5.125	14-Aug-15
578434-AL-2	34	57	84	1,919,697	1,404,543	-	3,652.3	-	16.0	0.0	6-16	Alluvium	2	5.125	14-Aug-15
578524-AL	24	57	85	1,934,069	1,381,927	3,671.6	3,673.9	2.3	35	40	20-40	Alluvium	5	8.75	8-Jan-18
578420-AL	20	57	84	1,931,385	1,392,945	3,632.7	3,634.4	1.7	17	20	6-16	Alluvium	2	5.5	18-Jun-18
578415-AL	15	57	84	1,936,458	1,404,303	3,573.1	3,576.0	2.9	34.0	24.0	24-34	Alluvium	2	4.25	19-Jul-19
578415-SPL-1	22	57	84	1,934,127	1,404,656	3,601.9	3,603.7	1.8	41	62	31-41	Spoil	2	5.125	24-May-18
578415-SPL-2	15	57	84	1,935,619	1,404,636	3,609.6	3,611.5	1.9	108	120	100-110	Spoil	2	5.125	25-May-18
578513-OVB-1	13	57	85	1,936,206	1,384,801	3,753.2	3,755.2	2.0	70	72	60-70	Overburden	2	5.5	6-Jun-18

Notes: [1]Exhibit RP.8-5 presents the location of the monitor wells.

[2]Reflects field measured depth from drilling log.

[3]Formation packer was not installed in any of the groundwater wells.

[4]2-inch diameter piezometers installed in core hole cluster R13-012.

[5]2-inch diameter piezometers installed in core hole cluster R13-018.

DEQ Ex. 6-090

Table RP.8-8. Water Quality Constituents

Constituent	Source[1]	Holding Time	Analytical Method
pH	GW,SW	At time of Sample	SM 4500 H B
Electrical Conductivity	GW, SW	28 Days	SM 2510B
Total Dissolved Solids (180)	GW, SW	7 Days	SM 2540
Sodium Adsorption Ratio (SAR)	GW, SW	NA	Calculation
Alkalinity, Total (as $CACO_3$)	GW, SW	14 Days	SM 2320B
Alkalinity, carbonate (as CO_3)	GW, SW	14 Days	SM 2320B
Alkalinity, Hydroxide (as OH)	GW, SW	14 Days	SM 2320B
Ammonia Nitrogen (as N)	GW, SW	28 Days	EPA 350.1
Total Suspended Solids	SW	7 Days	SM 2540
Turbidity	SW	48 Hours	SM 2130
Nitrate+Nitrite as N	GW, SW	28 Days	EPA 353.2
Alkalinity, bicarbonate as HCO_3	GW, SW	14 Days	SM 2320B
Boron	GW, SW	180 Days	EPA 200.7
Barium	GW, SW	180 Days	EPA 200.8
Copper	GW, SW	180 Days	EPA 200.8
Fluoride	GW, SW	28 Days	SM 4500FC
Sulfate	GW, SW	28 Days	EPA 300.0
Aluminum	GW, SW	180 Days	EPA 200.7
Arsenic	GW, SW	180 Days	EPA 200.8
Cadmium	GW, SW	180 Days	EPA 200.8
Calcium	GW, SW	180 Days	EPA 200.7
Chloride	GW, SW	28 Days	EPA 300.0
Chromium	GW, SW	180 Days	EPA 200.7
Iron	GW, SW	180 Days	EPA 200.7
Total Iron	GW, SW	180 Days	EPA 200.7
Lead	GW, SW	180 Days	EPA 200.8
Magnesium	GW, SW	180 Days	EPA 200.7
Manganese	GW, SW	180 Days	EPA 200.7
Total Manganese	GW, SW	180 Days	EPA 200.7
Molybdenum	GW, SW	180 Days	EPA 200.8
Nickel	GW, SW	180 Days	EPA 200.7
Potassium	GW, SW	180 Days	EPA 200.7
Selenium	GW, SW	180 Days	EPA 200.8
Sodium	GW, SW	180 Days	EPA 200.7
Mercury	GW, SW	28 Days	EPA 245.1
Total Mercury	GW, SW	28 Days	EPA 245.1
Zinc	GW, SW	180 Days	EPA 200.7

Note: [1] SW = Surface Water Monitoring, GW = Groundwater Monitoring

Table RP.8-9. Surface Water Monitoring Sites

Site ID	Facility Name	Location	Monitoring Device	Type and Frequency of Measurement
SM578512-SW-1	SM578512-SW-1 (Slater Creek)	SESW, Sec. 12, T57N, R85W	R	C, Q
SM578418-SW-1	SM578418-SW-1 (Slater Creek)	SESW, Sec. 18, T57N, R84W	R, PS	C, E, M
SM578409-SW-1	SM578409-SW-1 (Hidden Water Creek)	SWNW, Sec. 09, T57N, R84W	R	C, Q
SM578415-SW-1	SM578415-SW-1 (Hidden Water Creek)	SENW, Sec. 15, T57N, R84W	R	C, Q
SP578415_1	BIG HORN NO. 14 RESERVOIR	SESE, Sec. 15, T57N, R84W	NONE	Q
SP578415_2	BIG HORN NO. 2 RESERVOIR	SESE, Sec. 15, T57N, R84W	NONE	Q
SP578418	PERMANENT IMPOUNDMENT #1 RESERVOIR	NWSW, Sec. 18, T57N, R84W	NONE	Q
SP578514_1	LEGERSKI #1 STOCK RESERVOIR	SENE, Sec. 14, T57N, R85W	NONE	Q
SP578510	Upper 10 Stock Reservoir	NWSE, Sec. 10, T57N, R85W	NONE	Q
SP578514_2	Welch #4 Stock Reservoir	NWNW, Sec. 14, T57N, R85W	NONE	Q
SP578514_3	Black Mountain No. 1 Stock Reservoir	SENW, Sec. 14, T57N, R85W	NONE	Q
SP578515	Enhancement Stockpond 1	NWSE, Sec. 13, T57N, R85W	NONE	Q
SP578515	Replacement Stockpond 1	NESE, Sec. 13, T57N, R85W	NONE	Q
578514-TR-1	578514-TR-1	SWSW, Sec. 14, T57N, R85W	NONE	A
578524-TR-1	578524-TR-1	NENW, Sec. 24, T57N, R85W	NONE	Q, D
578420-TR-1	578420-TR-1	NWSE, Sec. 20, T57N, R84W	NONE	Q,D
578513-IRR-DITCH	578513-IRR-DITCH	SWSW, Sec. 13, T57N, R85W	NONE	Q, D
578434-GC-1	578434-GC-1	NESW, Sec. 34, T57N, R84W	NONE	Q[1]
USGS 06305700	Goose Creek near Acme, WY	NESE, Sec. 28, T57N, R84W	USGS Stream Gage Site	D
578401-TR-3	578401-TR-3	NESW, Sec. 01, T57N, R84W	NONE	Q, D

Monitoring devices

R=Flowmeter

PS=Pump sampler

Type and Frequency of Measurements

C=Continuous flowmeter

E=Pump sampler water quality sample based on precipitation event

M=Monthly grab sample if water is present

Q=Quarterly grab sample if water is present

D=Discharge measurement, if safe to do so at time of grab sample collection.

A=Alternate discharge measurement location.

Note: 1. For Goose Creek surface water monitoring, flow discharge data will be obtained from USGS 06305700.

TFN 6 2/025
RECD 09-20-19

Table RP.9-1. Wetlands Impacted During the Life of Mine

Type	Disturbed Acres	Affected Acres Downstream	Total Acres
Palustrine Aquatic Bed-Impoundment (PABh)	4.2	0.1	4.3
Palustrine Emergent Vegetation (PEM)	0.8	3.8	4.6
Palustrine Emergent Vegetation-Impoundment (PEMh)	0.6	1.1	1.7
Palustrine Unconsolidated Bed (PUB)	0.0	0.0	0.0
Total Wetland Acreage	**5.6**	**5.0**	**10.6**
Off-channel Reservoir	2.2	0.1	2.3
OAR Ephemeral Creeks or Draws (R6)	2.2	4.2	6.4
OAR Ephemeral Creeks-Artificial (R6r)	0.2	0.1	0.3
Total Other Aquatic Resources Acreage	**4.6**	**4.4**	**9**
Total Aquatic Resources Acreage[1]	**10.2**	**9.4**	**19.6**

Notes: [1] Reclaimed wetlands and OARs are presented in Exhibit RP.6-1.

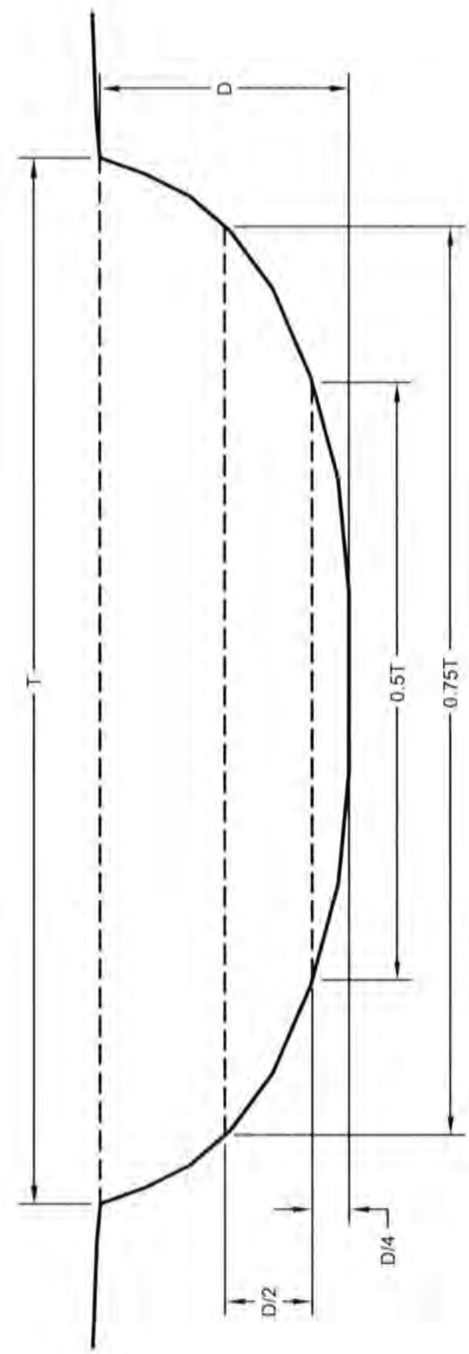

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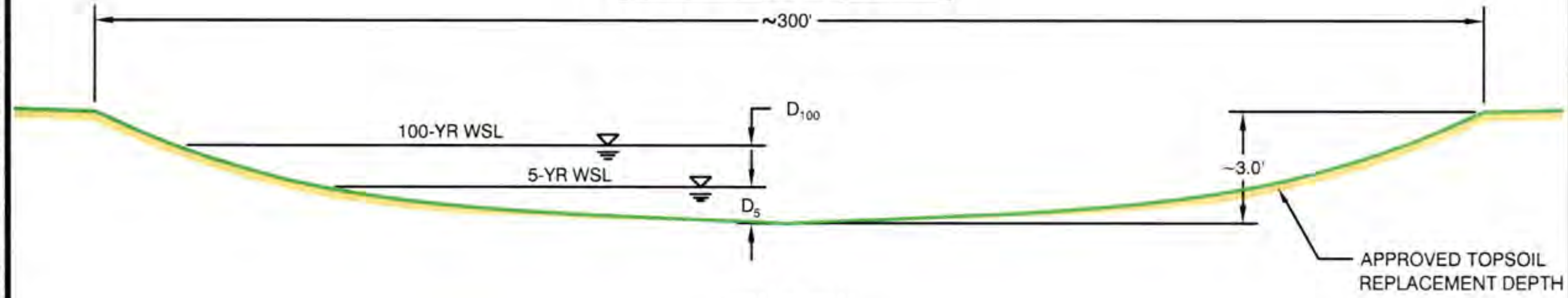
Figure RP.8-1. Generalized Cross Section for Reconstructed Parabolic Channels

POSTMINING



LOW FLOW

$Q_{(5,6)}$	442.3 cfs
AREA	159.22 sq ft
HYDRAULIC RADIUS	0.83 ft
WETTED PERIMETER	192.80 ft
VELOCITY	2.78 fps
MANNING'S n	0.052
SLOPE	0.0124 ft/ft
DEPTH OF FLOW (D_5)	1.24 ft

HIGH FLOW

$Q_{(100,6)}$	1199.1 cfs
AREA	253.19 sq ft
HYDRAULIC RADIUS	1.13 ft
WETTED PERIMETER	225.05 ft
VELOCITY	4.74 fps
MANNING'S n	0.038
SLOPE	0.0124 ft/ft
DEPTH OF FLOW (D_{100})	1.69 ft

Figure RP.8-2. Typical Hidden Water Creek Reconstructed Channel Cross Section

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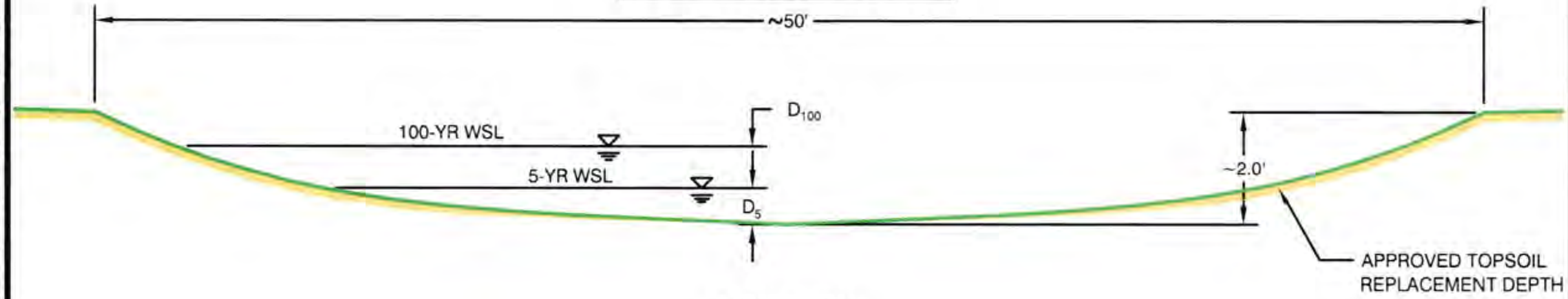
Figure RP.8-3. Typical HWCSUB1 Reconstructed Channel Cross Section

POSTMINING



LOW FLOW

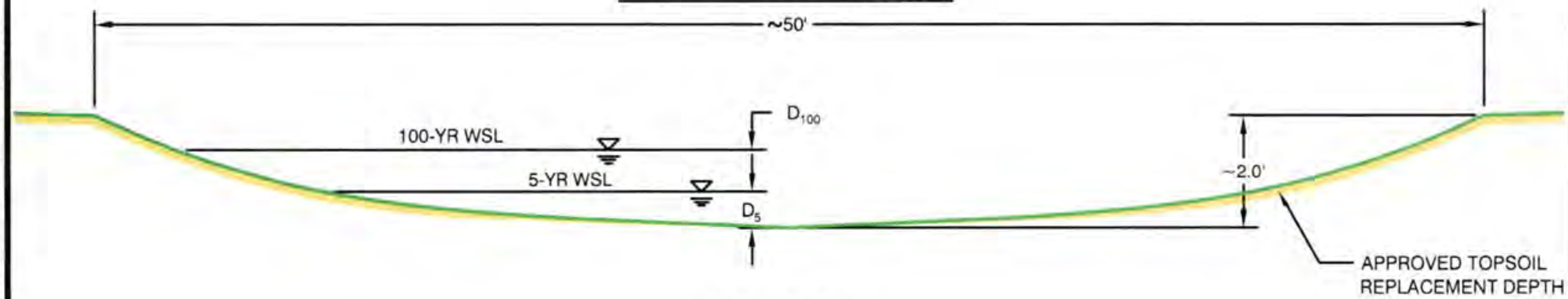
$Q_{(5.6)}$	28.9 cfs
AREA	12.82 sq ft
HYDRAULIC RADIUS	0.44 ft
WETTED PERIMETER	28.90 ft
VELOCITY	2.25 fps
MANNING'S n	0.082
SLOPE	0.0457 ft/ft
DEPTH OF FLOW (D_5)	0.67 ft

HIGH FLOW

$Q_{(100.6)}$	77.5 cfs
AREA	18.47 sq ft
HYDRAULIC RADIUS	0.57 ft
WETTED PERIMETER	32.65 ft
VELOCITY	4.20 fps
MANNING'S n	0.052
SLOPE	0.0457 ft/ft
DEPTH OF FLOW (D_{100})	0.85 ft

K:\Sheridan\RAMACO\13139\ACAD_WY83EC\DWGS_REC_PLAN\FIGURES\FG_RP-8-3_HWCSUB1.DWG 10/30/2014 8:12:48 AM condia gonzales

POSTMINING



LOW FLOW

$Q_{(5,6)}$	4.16 cfs
AREA	4.49 sq ft
HYDRAULIC RADIUS	0.22 ft
WETTED PERIMETER	20.35 ft
VELOCITY	0.93 fps
MANNING'S n	0.129
SLOPE	0.0483 ft/ft
DEPTH OF FLOW (D_5)	0.33 ft

HIGH FLOW

$Q_{(100,6)}$	32.16 cfs
AREA	10.27 sq ft
HYDRAULIC RADIUS	0.38 ft
WETTED PERIMETER	26.83 ft
VELOCITY	3.13 fps
MANNING'S n	0.055
SLOPE	0.0483 ft/ft
DEPTH OF FLOW (D_{100})	0.57 ft

TFN 6 2/025
RECD NOV 14, 2014

Figure RP.8-4. Typical TRD2 Reconstructed Channel Cross Section

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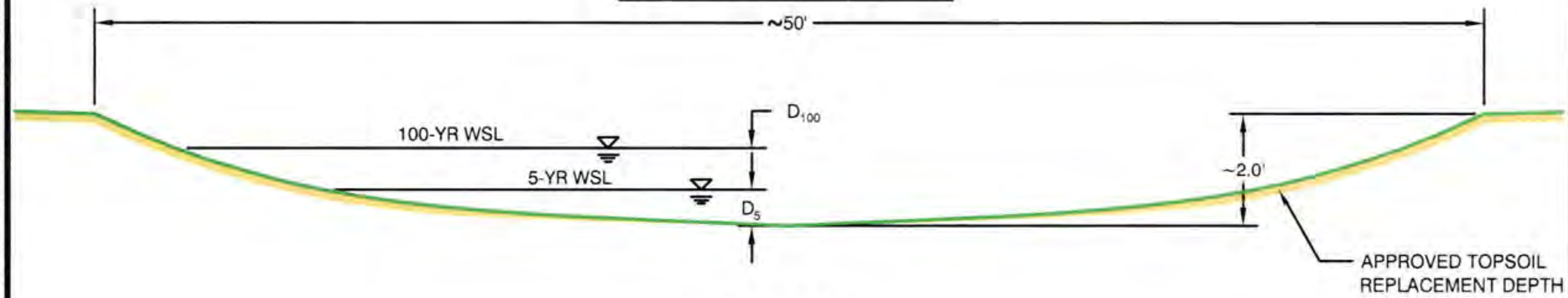
Figure RP.8-5. Typical TRD3 Reconstructed Channel Cross Section

POSTMINING



LOW FLOW

$Q_{(5,6)}$	4.76 cfs
AREA	4.8 sq ft
HYDRAULIC RADIUS	0.23 ft
WETTED PERIMETER	20.81 ft
VELOCITY	0.99 fps
MANNING'S n	0.122
SLOPE	0.0468 ft/ft
DEPTH OF FLOW (D_5)	0.35 ft

HIGH FLOW

$Q_{(100,6)}$	65.21 cfs
AREA	14.57 sq ft
HYDRAULIC RADIUS	0.48 ft
WETTED PERIMETER	30.16 ft
VELOCITY	4.48 fps
MANNING'S n	0.044
SLOPE	0.0468 ft/ft
DEPTH OF FLOW (D_{100})	0.73 ft

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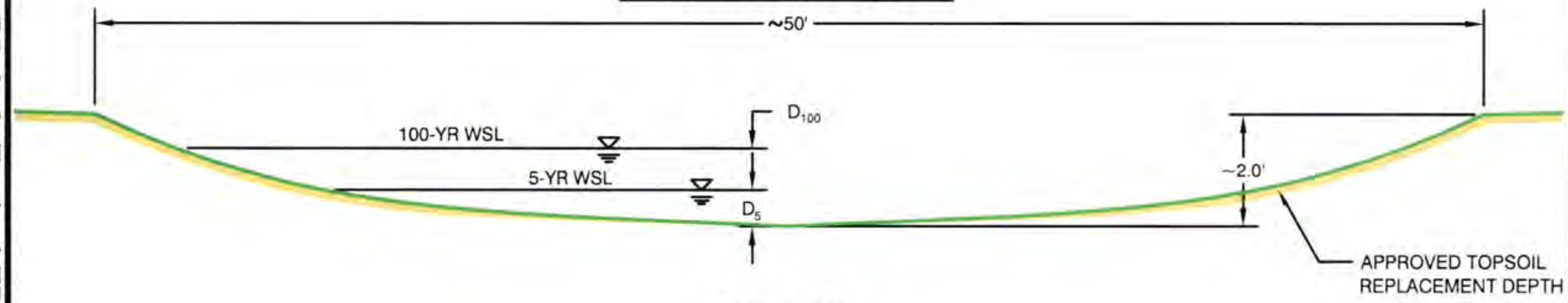
Figure RP.8-6. Typical TRD5 Reconstructed Channel Cross Section

POSTMINING



LOW FLOW

$Q_{(5,6)}$	24.19 cfs
AREA	11.55 sq ft
HYDRAULIC RADIUS	0.41 ft
WETTED PERIMETER	27.91 ft
VELOCITY	2.09 fps
MANNING'S n	0.090
SLOPE	0.0522 ft/ft
DEPTH OF FLOW (D_5)	0.62 ft

HIGH FLOW

$Q_{(100,6)}$	79.37 cfs
AREA	17.76 sq ft
HYDRAULIC RADIUS	0.55 ft
WETTED PERIMETER	32.23 ft
VELOCITY	4.47 fps
MANNING'S n	0.051
SLOPE	0.0522 ft/ft
DEPTH OF FLOW (D_{100})	0.83 ft

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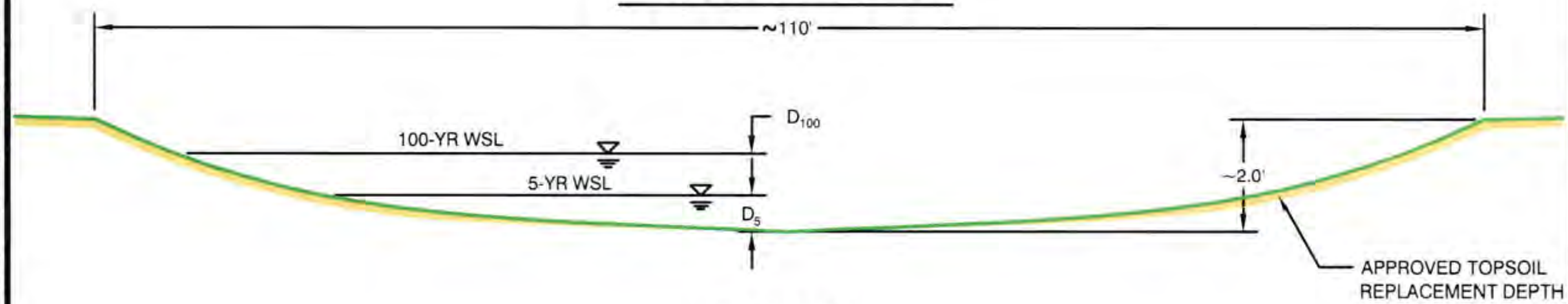

LOW FLOW

$Q_{(5,6)}$	24.58 cfs
AREA	14.01 sq ft
HYDRAULIC RADIUS	0.28 ft
WETTED PERIMETER	50.30 ft
VELOCITY	1.75 fps
MANNING'S n	0.081
SLOPE	0.0502 ft/ft
DEPTH OF FLOW (D_5)	0.42 ft

HIGH FLOW

$Q_{(100,6)}$	154.86 cfs
AREA	32.35 sq ft
HYDRAULIC RADIUS	0.49 ft
WETTED PERIMETER	66.48 ft
VELOCITY	4.79 fps
MANNING'S n	0.043
SLOPE	0.0502 ft/ft
DEPTH OF FLOW (D_{100})	0.73 ft

Figure RP.8-7. Typical SCSUB1 Reconstructed Channel Cross Section

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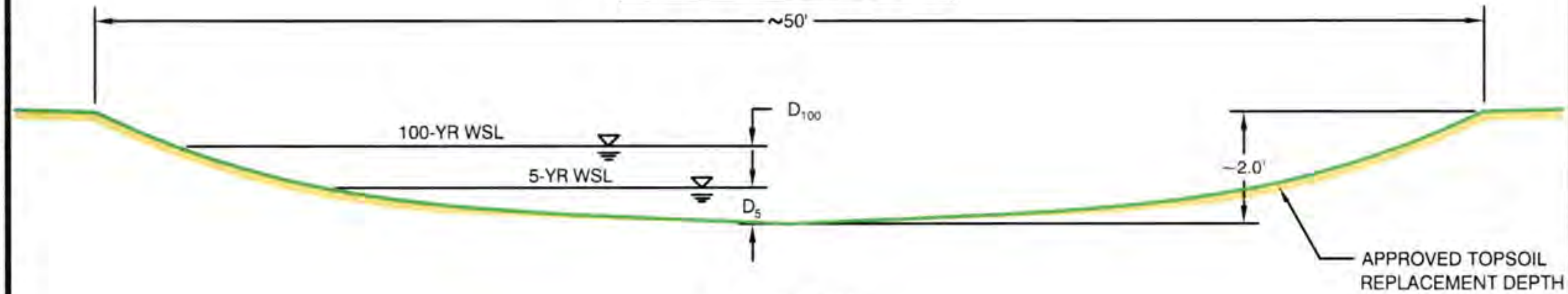
POSTMINING



LOW FLOW

$Q_{(5,6)}$	5.63 cfs
AREA	3.98 sq ft
HYDRAULIC RADIUS	0.20 ft
WETTED PERIMETER	19.56 ft
VELOCITY	1.41 fps
MANNING'S n	0.108
SLOPE	0.0873 ft/ft
DEPTH OF FLOW (D_5)	0.31 ft

HIGH FLOW

$Q_{(100,6)}$	33.90 cfs
AREA	8.38 sq ft
HYDRAULIC RADIUS	0.33 ft
WETTED PERIMETER	25.07 ft
VELOCITY	4.05 fps
MANNING'S n	0.052
SLOPE	0.0873 ft/ft
DEPTH OF FLOW (D_{100})	0.50 ft

Figure RP.8-8. Typical SCSUB5 Reconstructed Channel Cross Section

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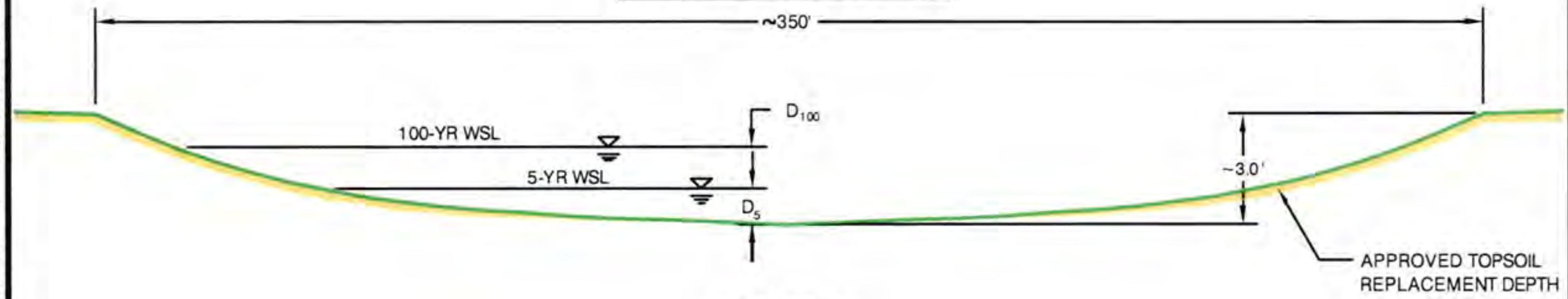
POSTMINING



LOW FLOW

$Q_{(5,6)}$	950.6 cfs
AREA	306.10 sq ft
HYDRAULIC RADIUS	1.15 ft
WETTED PERIMETER	265.69 ft
VELOCITY	3.11 fps
MANNING'S n	0.043
SLOPE	0.0067 ft/ft
DEPTH OF FLOW (D_5)	1.73 ft

HIGH FLOW

$Q_{(100,6)}$	2514.9 cfs
AREA	510.05 sq ft
HYDRAULIC RADIUS	1.62 ft
WETTED PERIMETER	315.00 ft
VELOCITY	4.93 fps
MANNING'S n	0.034
SLOPE	0.0067 ft/ft
DEPTH OF FLOW (D_{100})	2.43 ft

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Figure RP.8-9. Typical Slater Creek Reconstructed Channel Cross Section

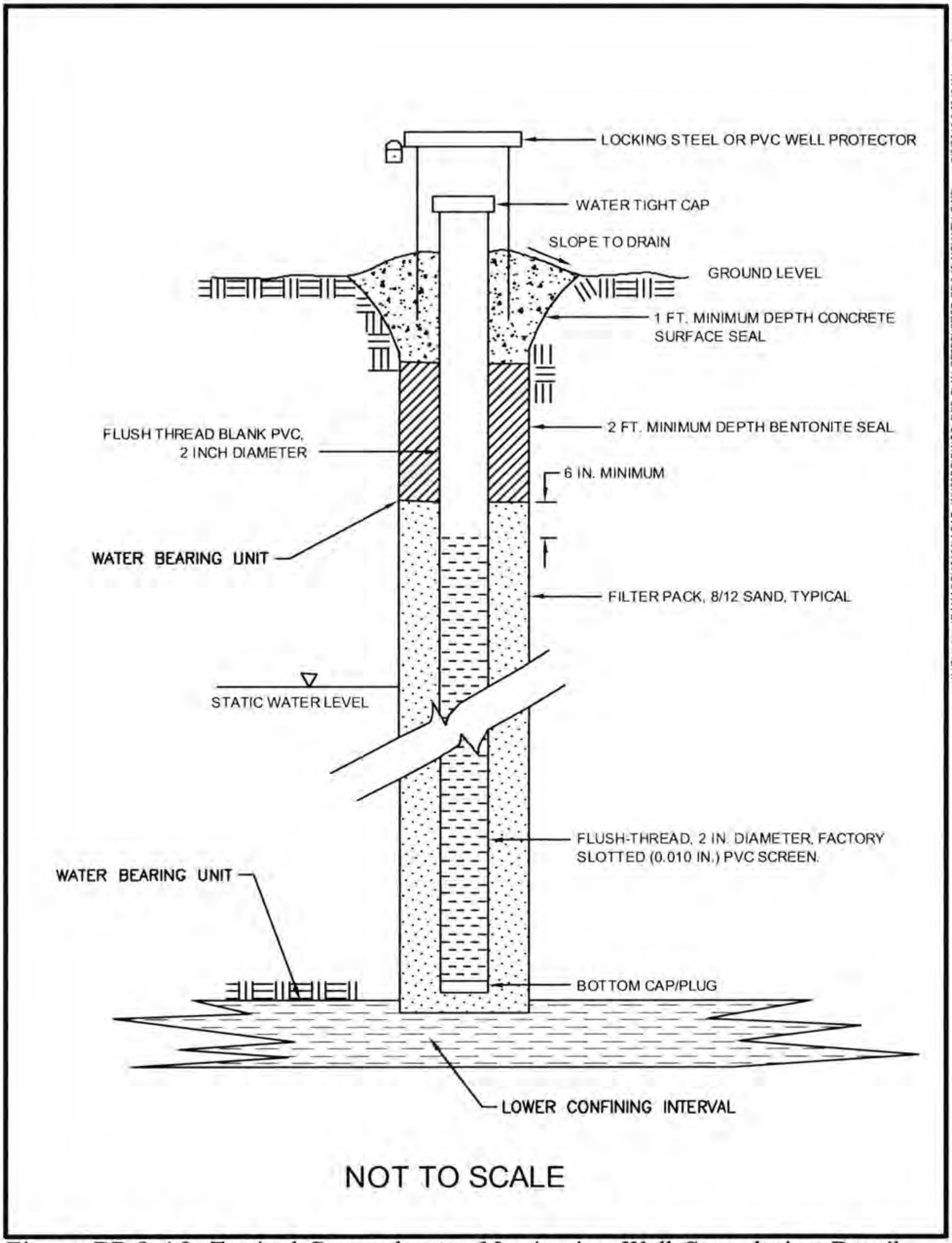

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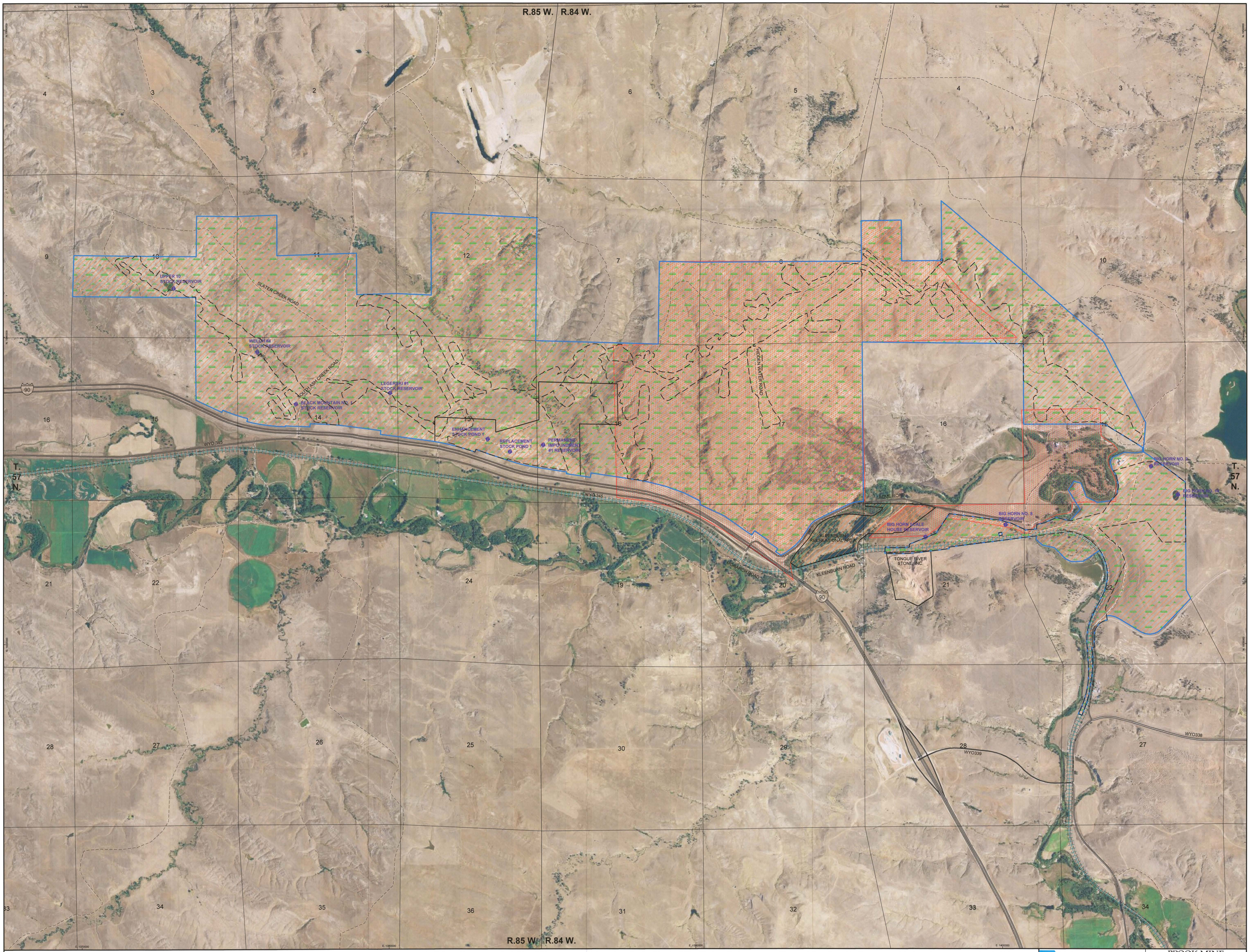
Figure RP.8-10. Typical Groundwater Monitoring Well Completion Details

TFN 6 2/025
RECD JUL 30, 2015



LEGEND

- BROOK MINE PERMIT BOUNDARY
- TAYLOR QUARRY PERMIT BOUNDARY (PERMIT NO. SP-757)
- PAVED ROADS
- MINOR ROADS
- AFFECTED AREA BOUNDARY
- RAILROAD
- POSTMINE RECREATIONAL USE AREA
- POSTMINE GRAZING LAND USE AREA WITHIN PERMIT BOUNDARY
- WYOMING GAME AND FISH HUNTER MANAGEMENT WALK-IN AREAS (WIAs)
- ENHANCEMENT STOCK POND 1 — PERMANENT POSTMINE IMPOUNDMENT

0 500 1,000 1,500 2,000
GRAPHIC SCALE (FEET)

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY

1101 SUGARVIEW DR. STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description
06/15	ROUND 1 COMMENTS
10/15	ROUND 2 COMMENTS
08/18	ROUND 7 COMMENTS
09/19	ROUND 10 COMMENTS

EXHIBIT RP.2-1

TFN 6 2/025
RECD 09-20-19

POSTMINE LAND USE

Drawn By: DCJ
Checked By: JGB
Date: 11/1/14

WWC ENGINEERING
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FILE: RP-2-1_PM_LANDUSE.dwg

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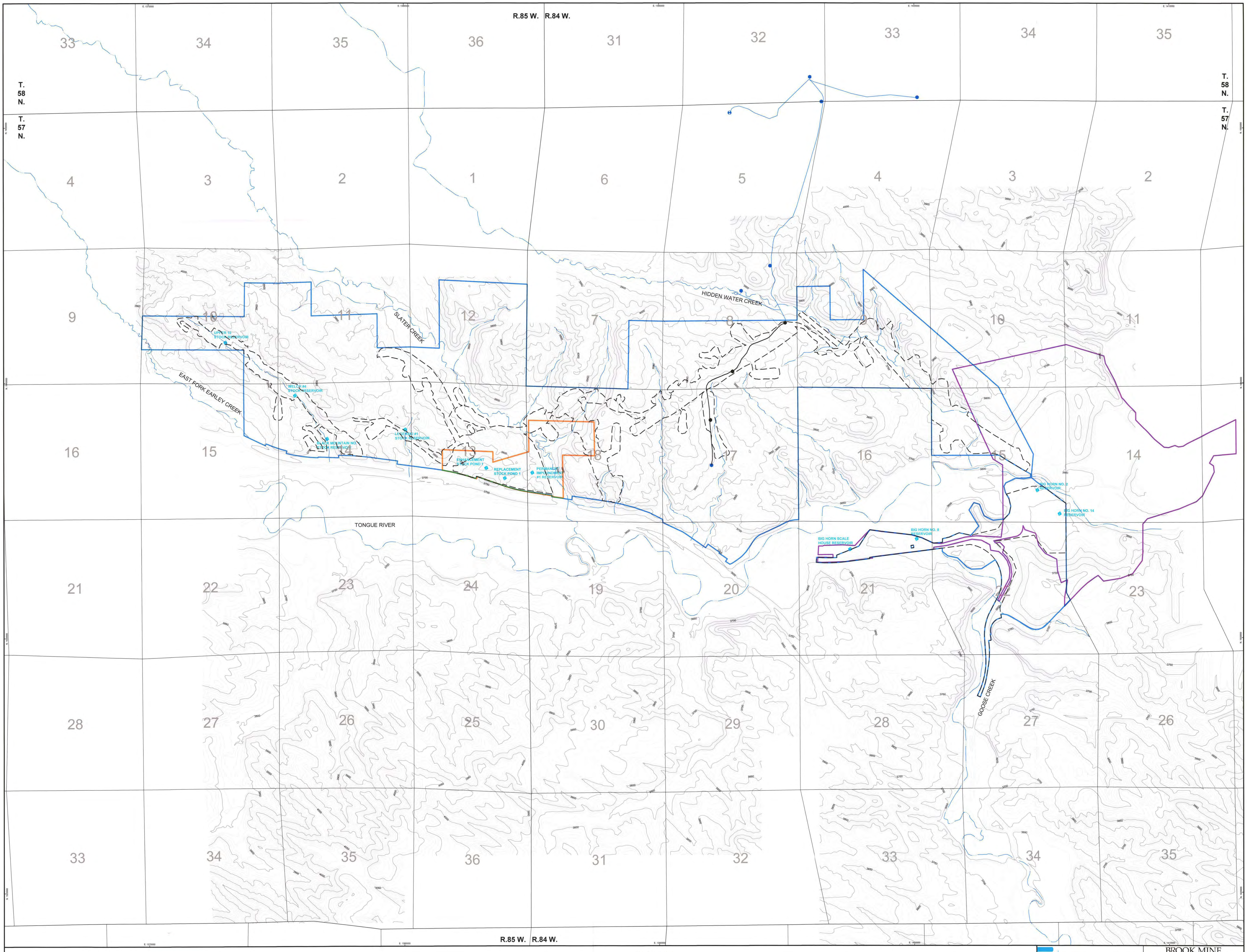

LEGEND

- BROOK MINE PERMIT BOUNDARY
- AFFECTED AREA BOUNDARY
- TAYLOR QUARRY PERMIT BOUNDARY (PERMIT NO. SP-757)
- BIG HORN COAL PERMIT BOUNDARY (PERMIT NO. 213-T7)
- WELCH #4 STOCK RESERVOIR — PERMANENT POSTMINE IMPOUNDMENT
- EXISTING STOCK TANK WATER LINE
- EXISTING EXISTING STOCK TANK
- RECLAIMED STOCK TANK WATER LINE
- RECLAIMED STOCK TANK

N

0 500 1,000 1,500 2,000
GRAPHIC SCALE (FEET)
C.I. = 10'

DEQ Ex. 6-105

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY

1101 SUGARVIEW DR. STE. 201
SHERIDAN, WY 82801

REVISIONS

Date	Description
06/15	ROUND 1 COMMENTS
10/15	ROUND 2 COMMENTS
09/16	ROUND 6 COMMENTS
08/18	ROUND 7 COMMENTS
09/19	ROUND 10 COMMENTS

EXHIBIT RP.3-1

TFN 6 2/025
RECD 09-20-19

POSTMINE
TOPOGRAPHY

Drawn By: DCJ
Checked By: JGB
Date: 11/1/14

WWC ENGINEERING
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FILE: RP-3-1_PM_TOPO.dwg

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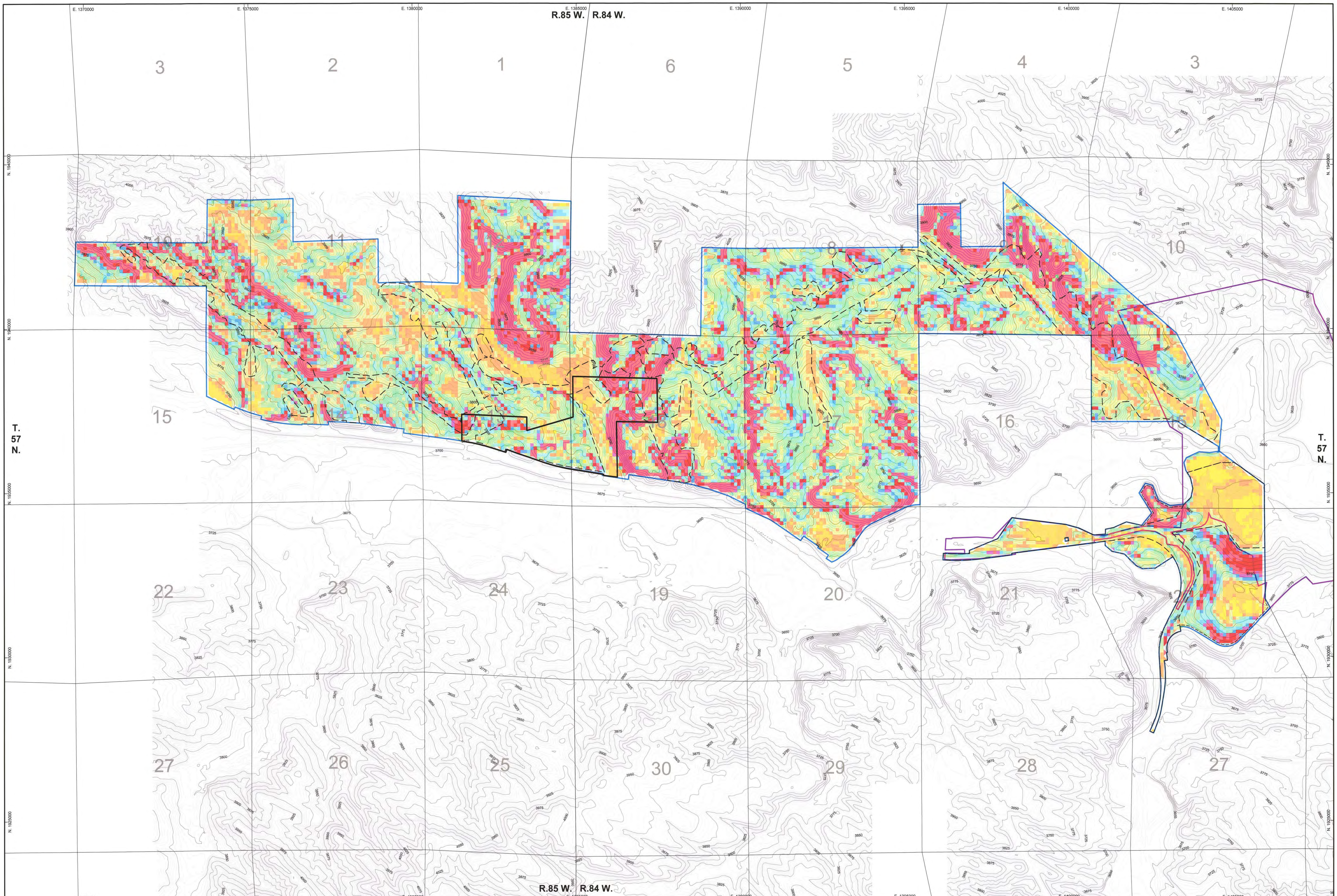


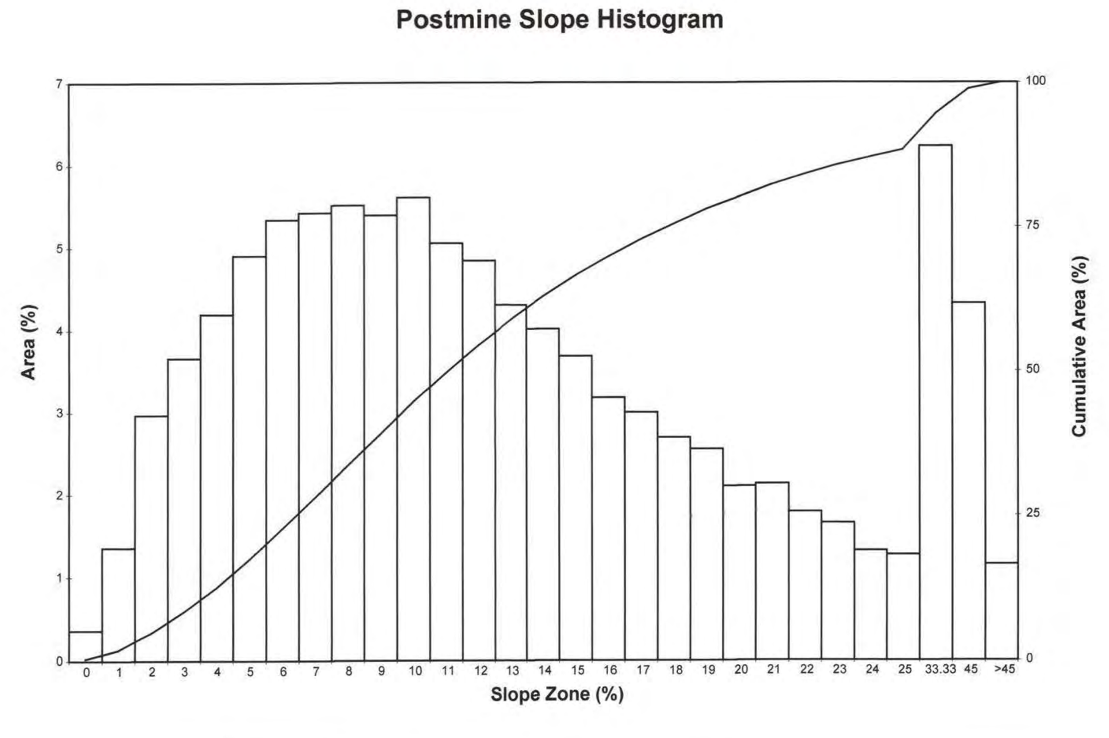
Slope Zone (percent)	Area (acres)	Percent of Total (percent)	Accumulated Percent (percent)
0	15.38	0.35	0.35
1	59.46	1.36	1.71
2	130.05	2.97	4.67
3	160.47	3.66	8.33
4	184.00	4.20	12.53
5	215.11	4.90	17.43
6	234.16	5.34	22.77
7	237.83	5.42	28.19
8	241.97	5.52	33.71
9	236.57	5.39	39.10
10	245.98	5.61	44.71
11	221.65	5.05	49.77
12	212.35	4.84	54.61
13	188.82	4.31	58.91
14	176.19	4.02	62.93
15	161.50	3.68	66.61
16	139.35	3.18	69.79
17	131.43	3.00	72.79
18	118.11	2.69	75.48
19	111.92	2.55	78.03
20	92.17	2.10	80.14
21	93.55	2.13	82.27
22	78.40	1.79	84.06
23	72.54	1.65	85.71
24	57.85	1.32	87.03
25	55.79	1.27	88.30
33.33	273.07	6.23	94.53
45	189.39	4.32	98.85
>45	50.62	1.15	100.00

Average Slope: 13.40%

Minimum Slope: 0.00%

Maximum Slope: 69.50%

Postmine Slope Histogram



LEGEND

- BROOK MINE PERMIT BOUNDARY
- BIG HORN COAL PERMIT BOUNDARY (PERMIT NO. 213-T7)
- TAYLOR QUARRY PERMIT BOUNDARY (PERMIT NO. SP-757)
- AFFECTED AREA BOUNDARY

SLOPE RANGES (%)

0.00 to 1.00	12.00 to 13.00
1.00 to 2.00	13.00 to 14.00
2.00 to 3.00	14.00 to 15.00
3.00 to 4.00	15.00 to 16.00
4.00 to 5.00	16.00 to 17.00
5.00 to 6.00	17.00 to 18.00
6.00 to 7.00	18.00 to 19.00
7.00 to 8.00	19.00 to 20.00
8.00 to 9.00	20.00 to 25.00
9.00 to 10.00	25.00 to 33.33
10.00 to 11.00	33.33 to 45.00
11.00 to 12.00	> 45.00

Drawing Coordinates: WY83ECF

CERTIFICATE OF ENGINEER

I, Jeffrey G. Barron, hereby certify that this drawing was prepared by myself or by engineers under my direct supervision and that it correctly represents the conditions described in the accompanying application which is designed to meet the requirements of the Wyoming Environmental Quality Act and its accompanying regulations.

Professional Engineer (Civil) JEFFREY G. BARRON 13033 DATE 9/20/2019 WYOMING

0 500 1,000 1,500 2,000
GRAPHIC SCALE (FEET)
C.I. = 5'

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY
1101 SUGARVIEW DR. STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description
10/15	ROUND 2 COMMENTS
08/18	ROUND 7 COMMENTS
09/19	ROUND 10 COMMENTS

EXHIBIT RP.3-2

TFN 6 2/025
RECD 09-20-19

POSTMINE SLOPE ANALYSIS

Drawn By: DCJ
Checked By: JGB
Date: 10/14/14

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FILE: RP-3-2_PM_SLOPE_ANALY.dwg

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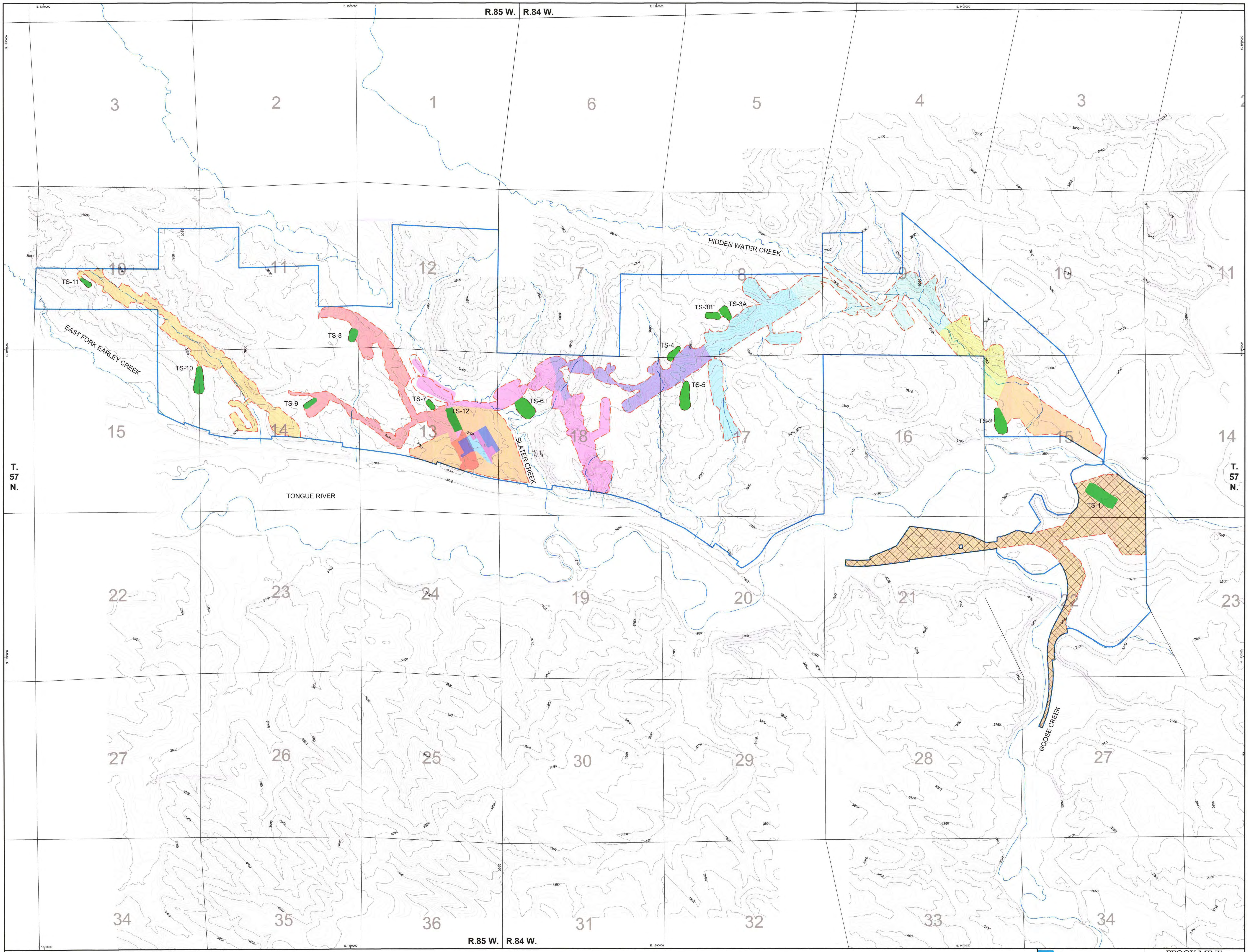

LEGEND

BROOK MINE PERMIT BOUNDARY

AFFECTED AREA BOUNDARY

TOPSOIL STOCKPILE LOCATION

TOPSOIL REPLACEMENT SEQUENCE

- YEAR 2
- YEAR 3
- YEAR 4
- YEAR 5
- YEARS 6 - 10
- YEARS 6 - 10 POTENTIAL
- YEARS 11 - 15
- YEARS 16 - 20
- YEARS 21 - 25
- YEARS 26 - 30
- YEARS 31 - 35
- YEARS 36 - 39
- YEARS 40 - 43

NOTE:
YEAR 2 CORRESPONDS TO YEAR 2021.

GRAPHIC SCALE (FEET) C.I. = 10'

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY

1101 SUGARVIEW DR. STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description
06/15	ROUND 1 COMMENTS
10/15	ROUND 2 COMMENTS
12/15	ROUND 3 COMMENTS
08/18	ROUND 7 COMMENTS
09/19	ROUND 10 COMMENTS
12/19	ROUND 11 COMMENTS

EXHIBIT RP.5-1

TOPSOIL REPLACEMENT SEQUENCE

TFN6 2/025
RECD DEC 13, 2019

Drawn By: CIG
Checked By: JGB
Date: 11/1/14

WWC ENGINEERING
www.wwcengineering.com

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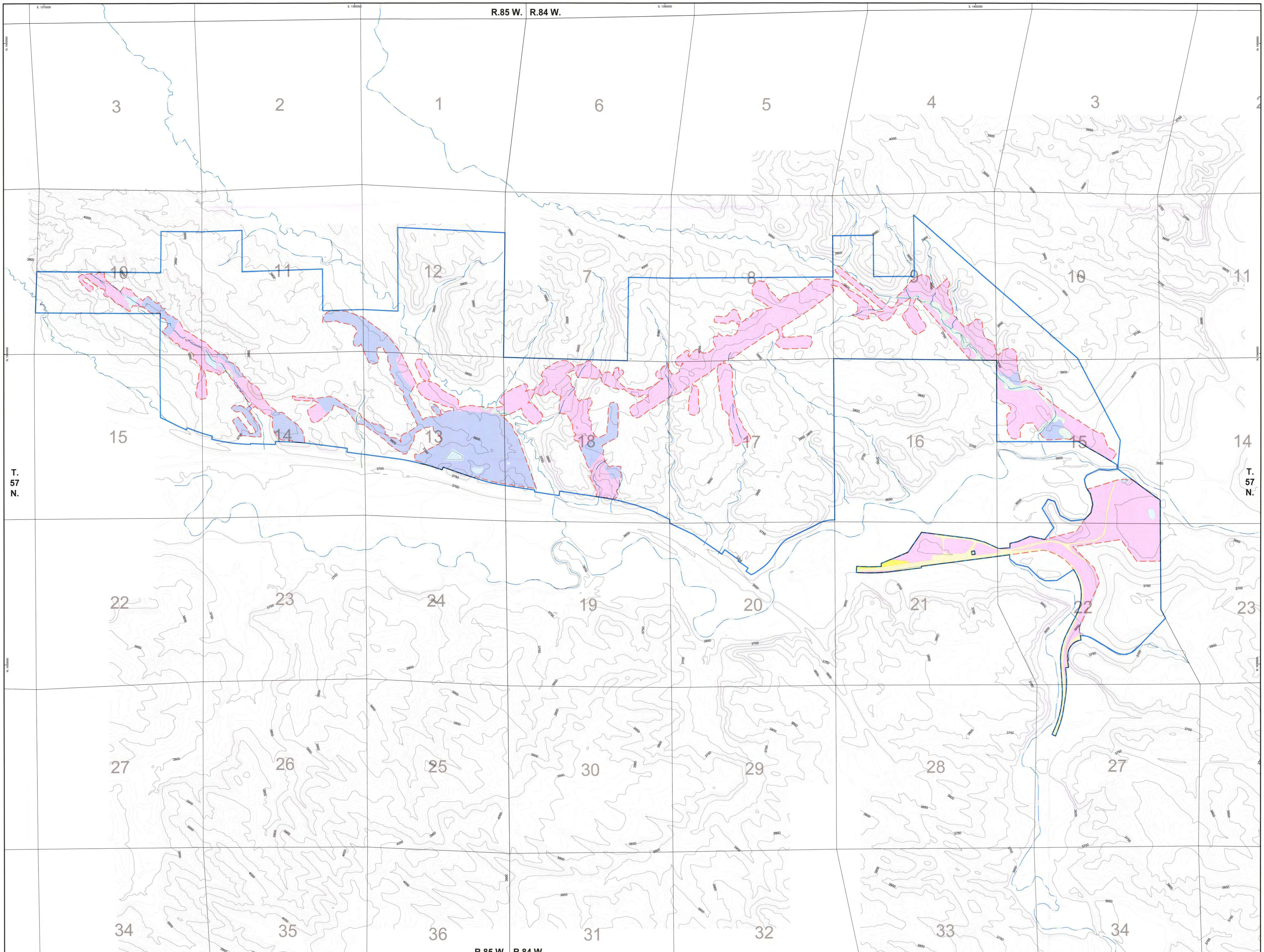

LEGEND

BROOK MINE PERMIT BOUNDARY
AFFECTED AREA BOUNDARY

POSTMINE VEGETATION COMMUNITIES

AG - HAYLAND
BG - BOTTOMLAND GRASSLAND
D - DISTURBED
SL - SHRUBLAND
UG - UPLAND GRASSLAND
W - WATER

GRAPHIC SCALE (FEET)
C.I. = 10'

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY

1101 SUGARVIEW DR. STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description
06/15	ROUND 1 COMMENTS
10/15	ROUND 2 COMMENTS
08/18	ROUND 7 COMMENTS
09/18	ROUND 10 COMMENTS

EXHIBIT RP.6-1

TFN 6 2/025
RECD 09-20-19

POSTMINE VEGETATION COMMUNITIES

Drawn By: CIG
Checked By: JGB
Date: 11/1/14

FILE: RP-6-1_VEG_REPLACE.dwg

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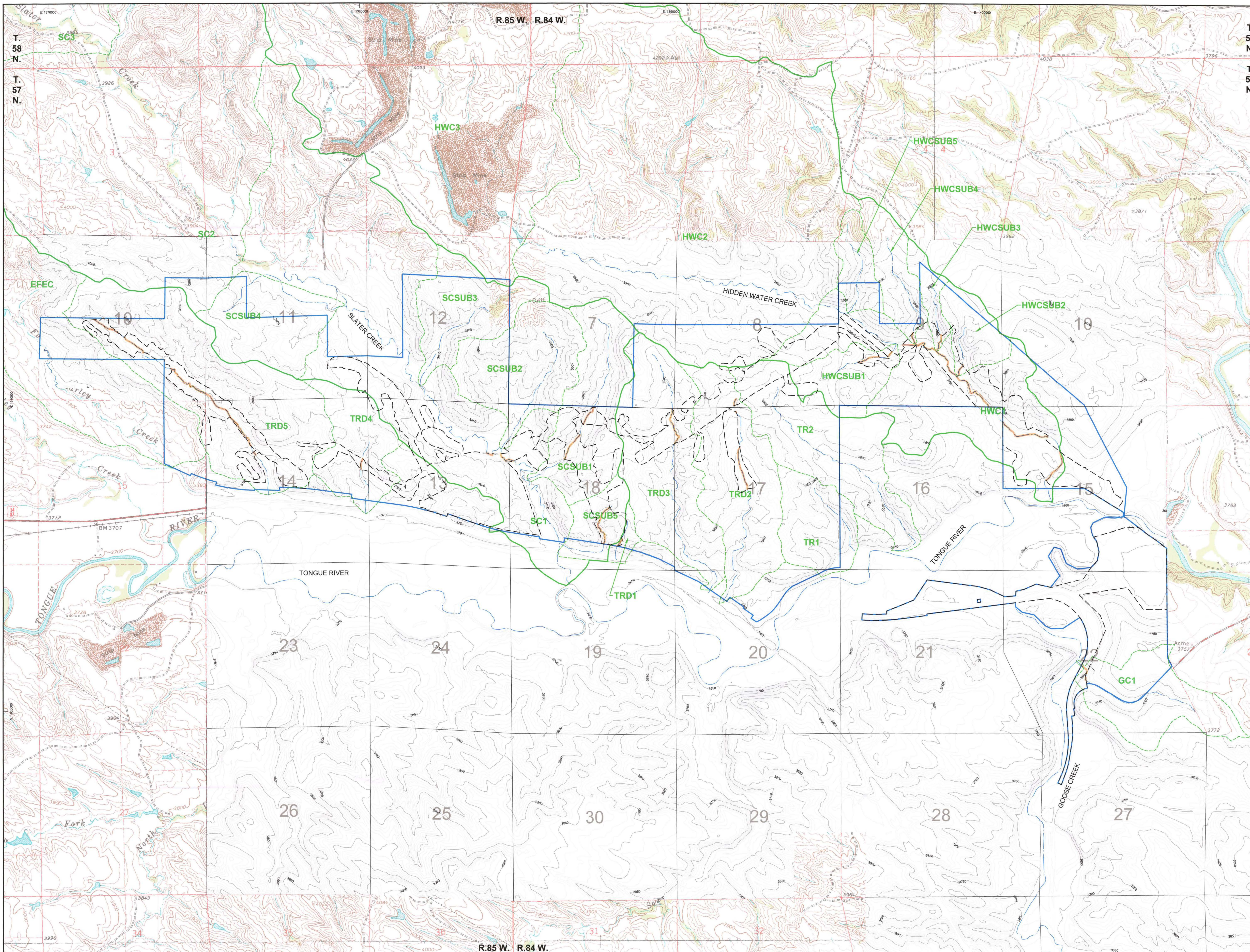

LEGEND

	BROOK MINE PERMIT BOUNDARY
	MAJOR DRAINAGE DIVIDE
	MINOR DRAINAGE DIVIDE
	AFFECTED AREA BOUNDARY
	CHANNEL PROFILE (NOT DISTURBED)
	CHANNEL PROFILE (DISTURBED)
TRD4	DRAINAGE BASIN ID

CERTIFICATE OF ENGINEER

I, Jeffrey G. Barron, hereby certify that this drawing was prepared by myself or by engineers under my direct supervision and that it correctly represents the conditions described in the accompanying application which is designed to meet the requirements of the Wyoming Environmental Quality Act and its accompanying regulations.

Professional Engineer (Civil)
JEFFREY G. BARRON
13033
DATE 9/20/2019
WYOMING

GRAPHIC SCALE (FEET)
0 500 1,000 1,500 2,000
C.I. = VARIES

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY
1101 SUGARVIEW DR. STE. 201
SHERIDAN, WY 82801

REVISIONS

Date	Description
06/15	ROUND 1 COMMENTS
10/15	ROUND 2 COMMENTS
08/18	ROUND 7 COMMENTS
09/19	ROUND 10 COMMENTS

EXHIBIT RP.8-1

TFN 6 2/025
RECD 09-20-19

FINAL HYDROLOGIC RECONSTRUCTION

Drawn By: DCJ
Checked By: JGB
Date: 11/1/14

WWC ENGINEERING
www.wwcengineering.com

FILE: RP-8-1_FINAL_HYDRO_RECON.dwg

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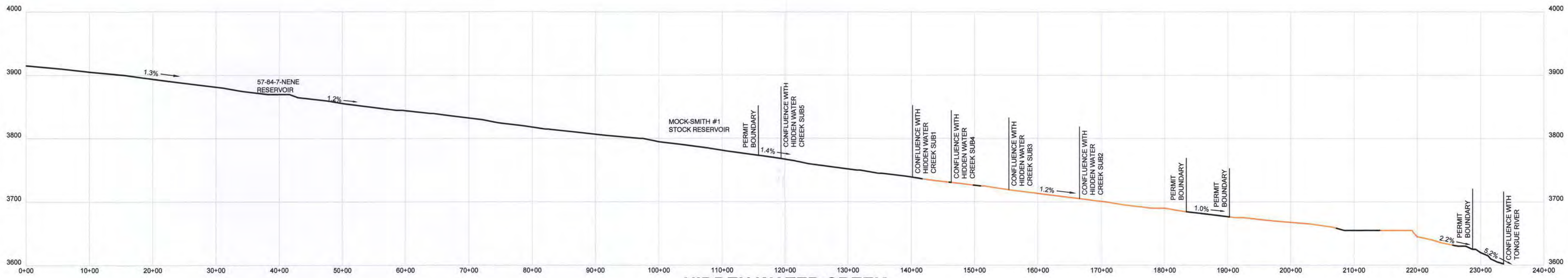
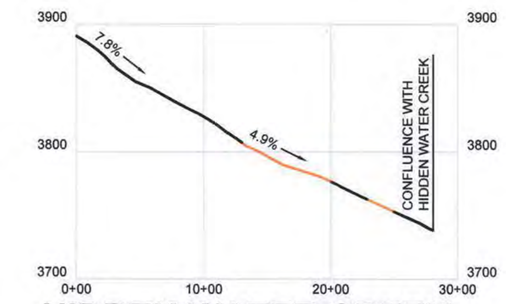


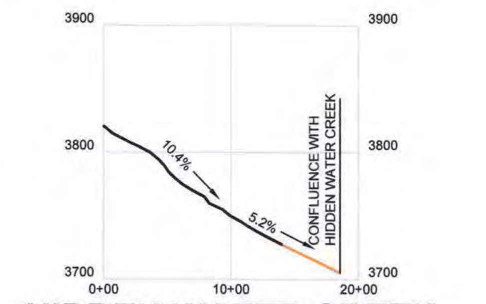
HIDDEN WATER CREEK LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



HIDDEN WATER CREEK SUB1 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



HIDDEN WATER CREEK SUB2 LONGITUDINAL CHANNEL PROFILE

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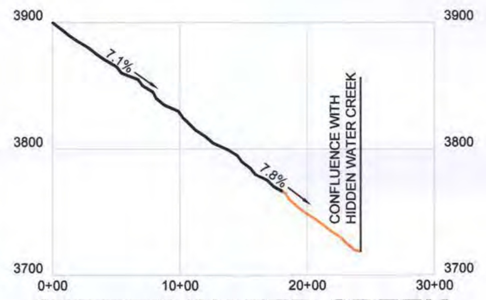
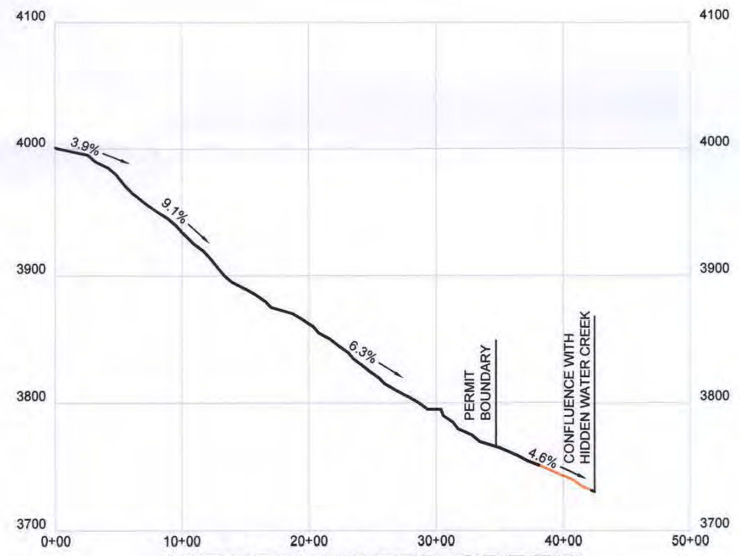


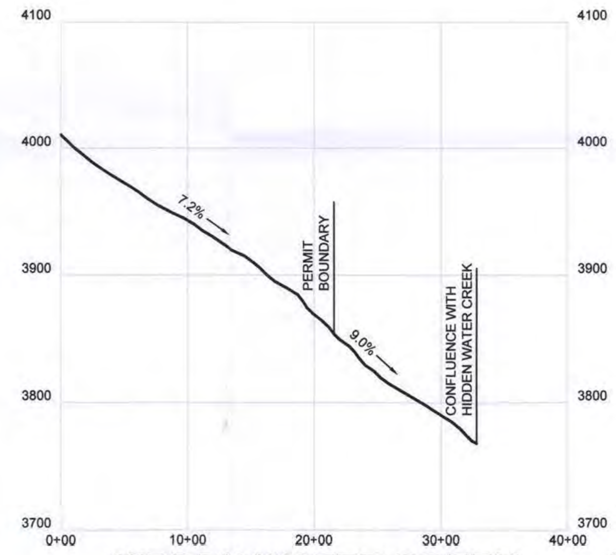
HIDDEN WATER CREEK SUB3 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



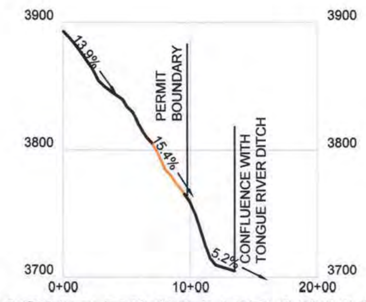
HIDDEN WATER CREEK SUB4 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



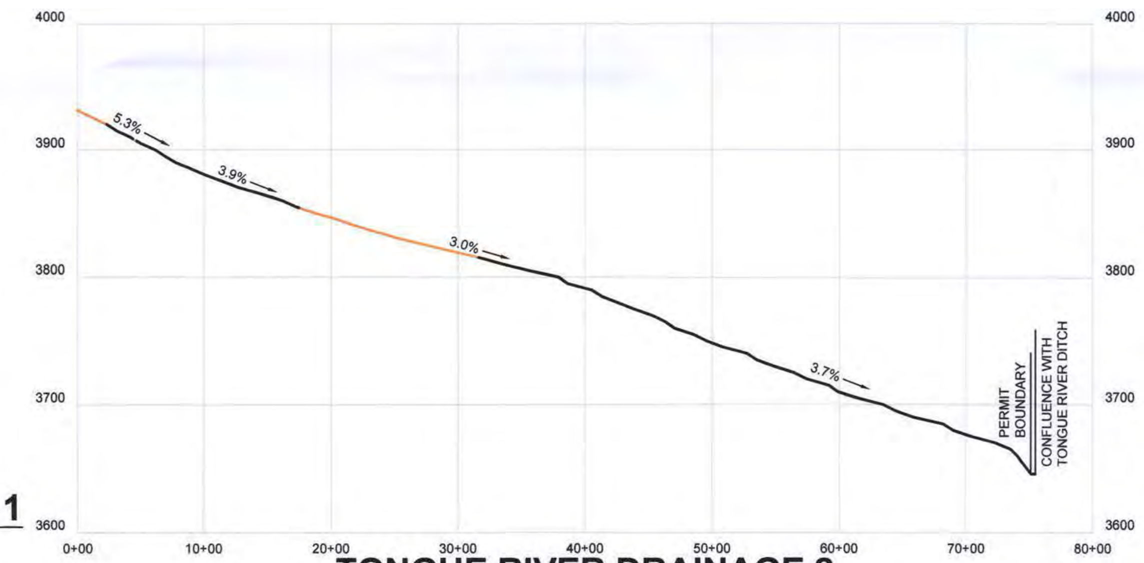
HIDDEN WATER CREEK SUB5 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



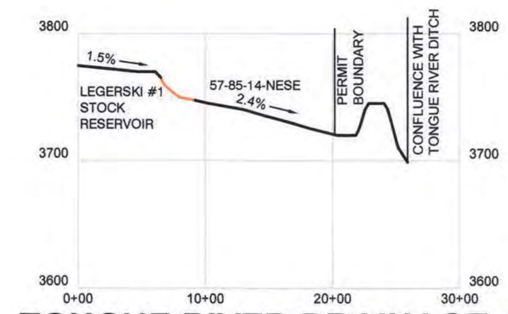
TONGUE RIVER DRAINAGE 1 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



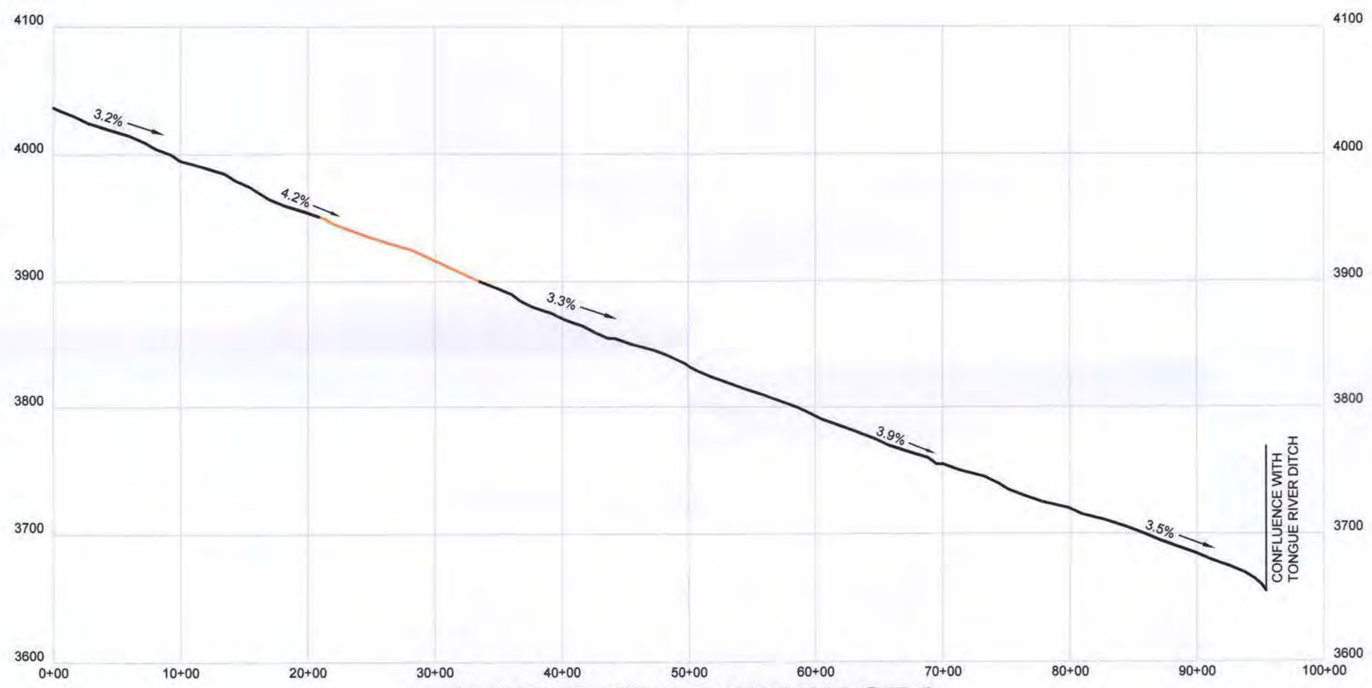
TONGUE RIVER DRAINAGE 2 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



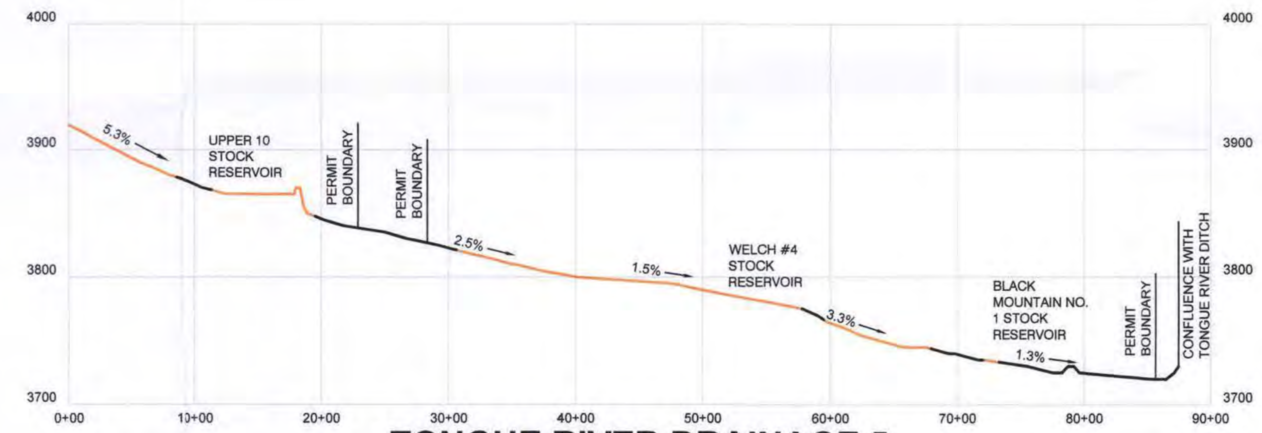
TONGUE RIVER DRAINAGE 4 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



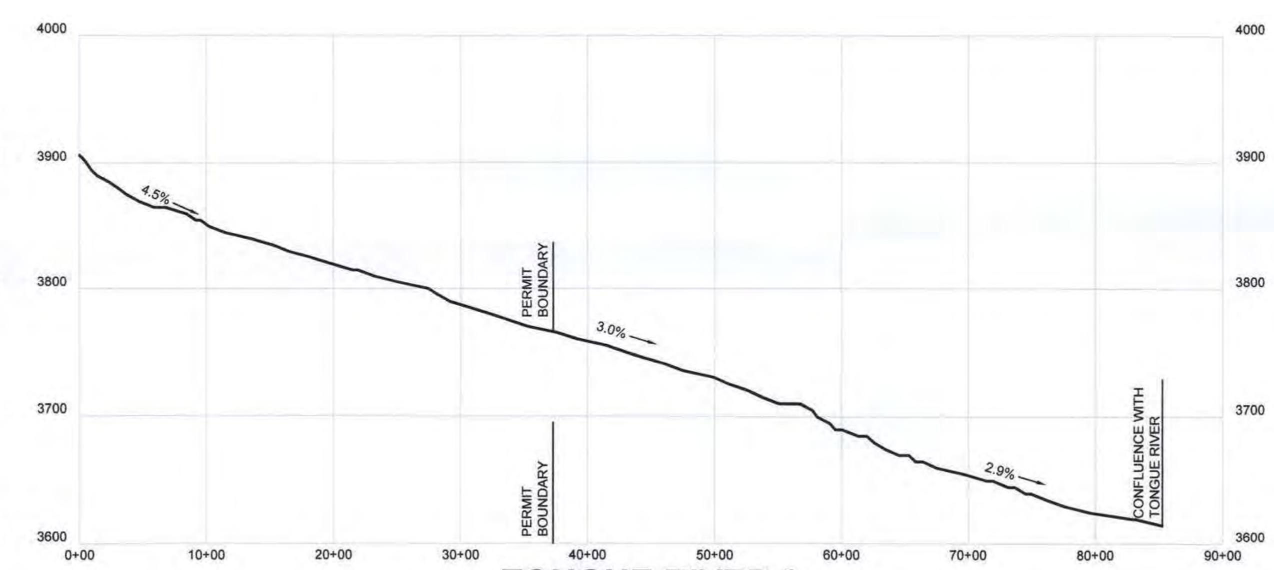
TONGUE RIVER DRAINAGE 3 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



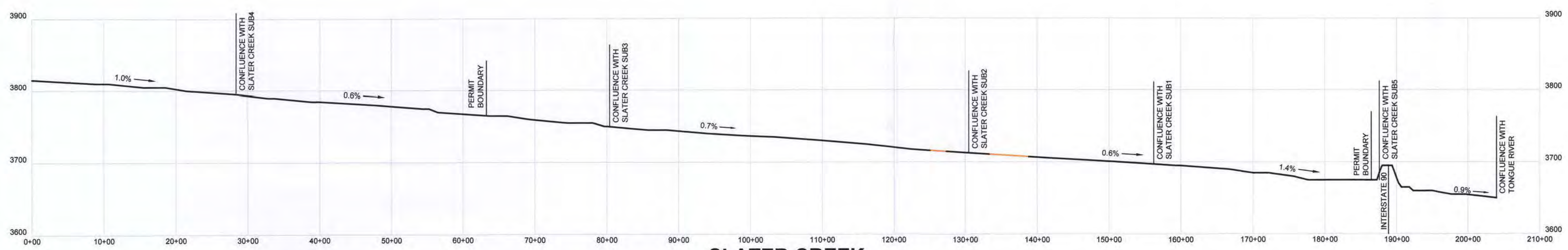
TONGUE RIVER DRAINAGE 5 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



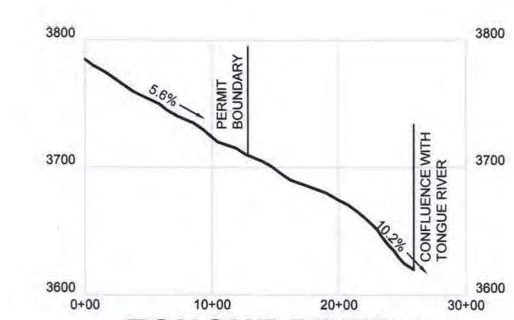
TONGUE RIVER 2 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



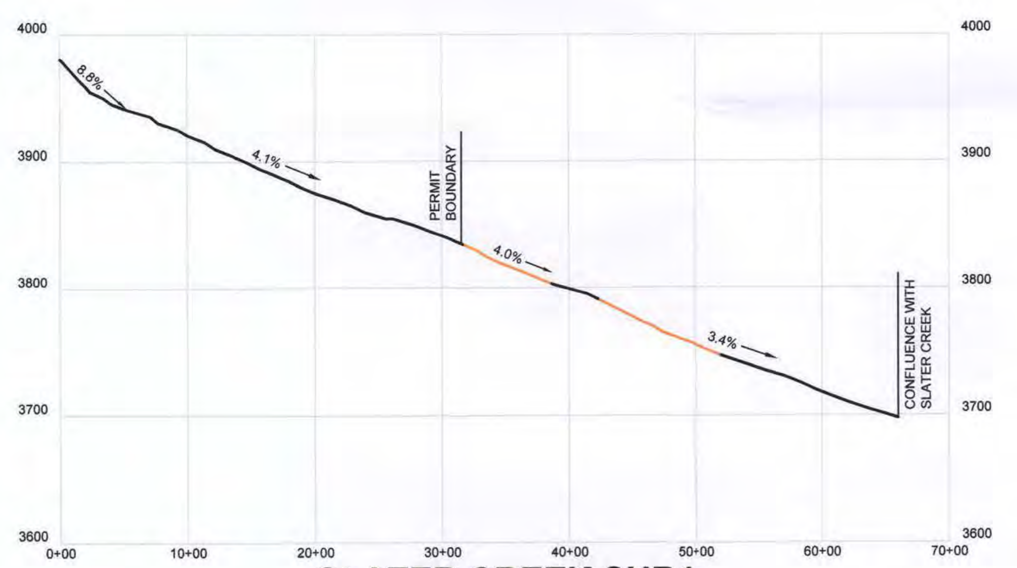
SLATER CREEK LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



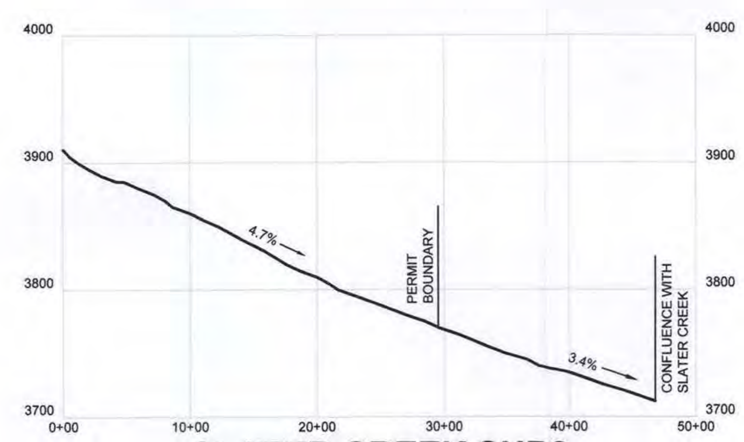
TONGUE RIVER 1 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



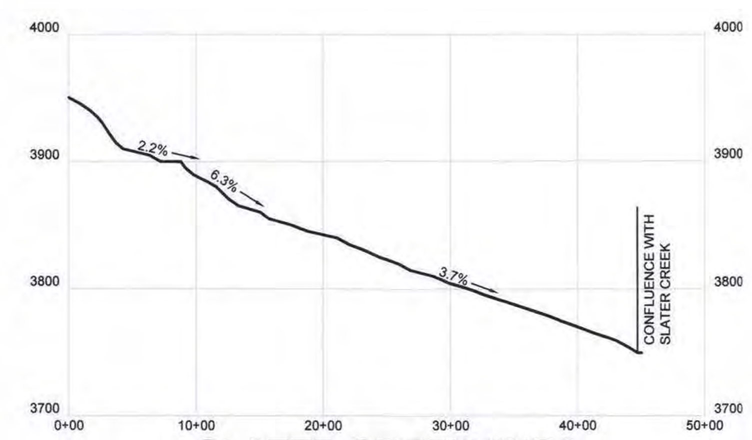
SLATER CREEK SUB1 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



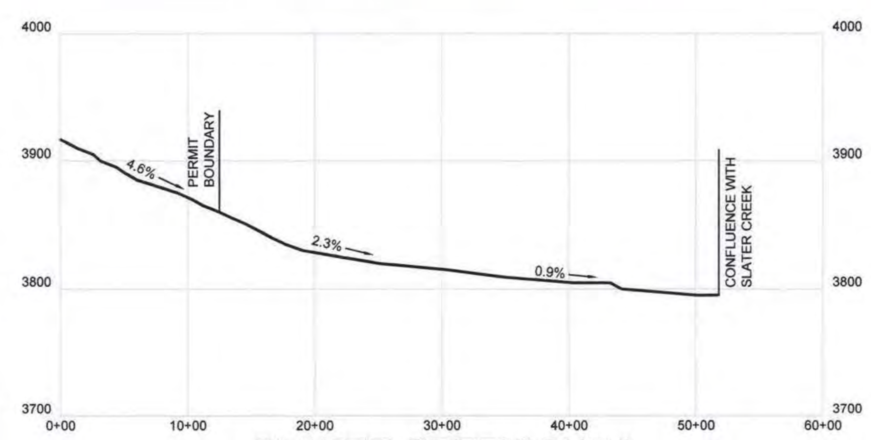
SLATER CREEK SUB2 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



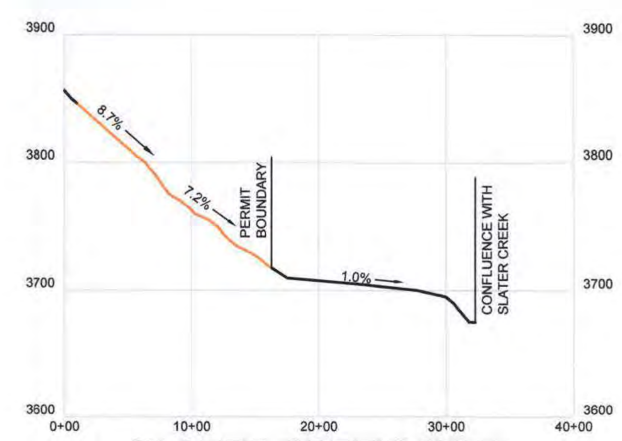
SLATER CREEK SUB3 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



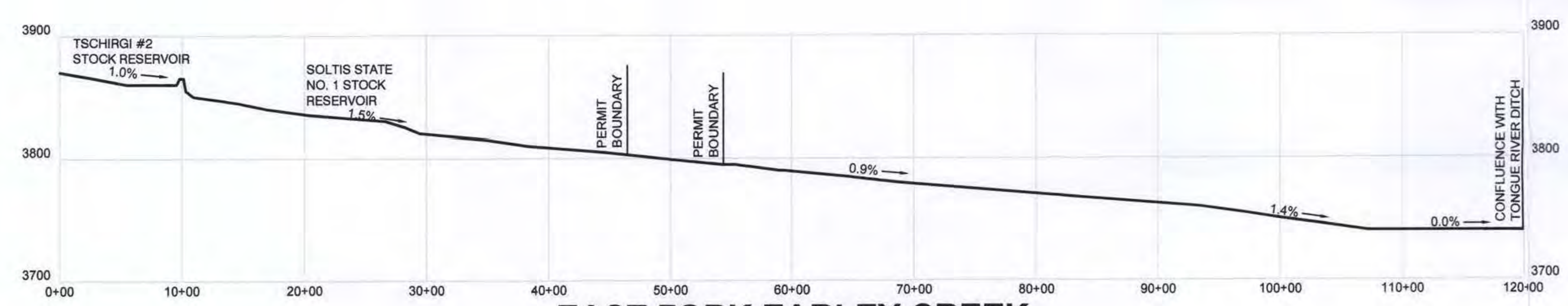
SLATER CREEK SUB4 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



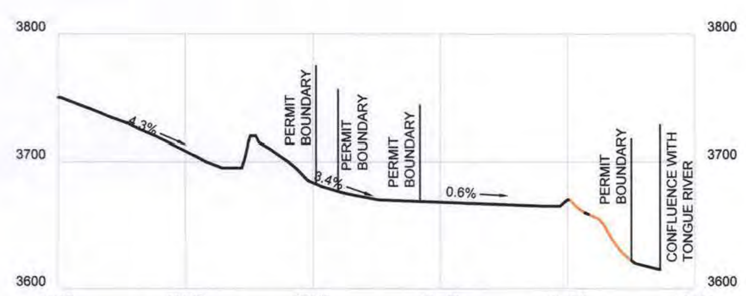
SLATER CREEK SUB5 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



EAST FORK EARLEY CREEK LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'



GOOSE CREEK 1 LONGITUDINAL CHANNEL PROFILE

SCALE: HORZ. 1" = 1000', VERT. 1" = 100'

CERTIFICATE OF ENGINEER

I, Jeffrey G. Barron, hereby certify that this drawing was prepared by myself or by engineers under my direct supervision and that it correctly represents the conditions described in the accompanying application which is designed to meet the requirements of the Wyoming Environmental Quality Act and its accompanying regulations.

Professional Engineer (Civil) JEFFREY G. BARRON 13033 DATE 10/18/2018 WYOMING

LEGEND

CHANNEL PROFILE (NON DISTURBED)

CHANNEL PROFILE (DISTURBED)

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY
1101 SUGARVIEW DR. STE. 201
SHERIDAN, WY 82801

REVISIONS

Date	Description
06/15	ROUND 1 COMMENTS
10/15	ROUND 2 COMMENTS
08/18	ROUND 7 COMMENTS

EXHIBIT RP.8-2

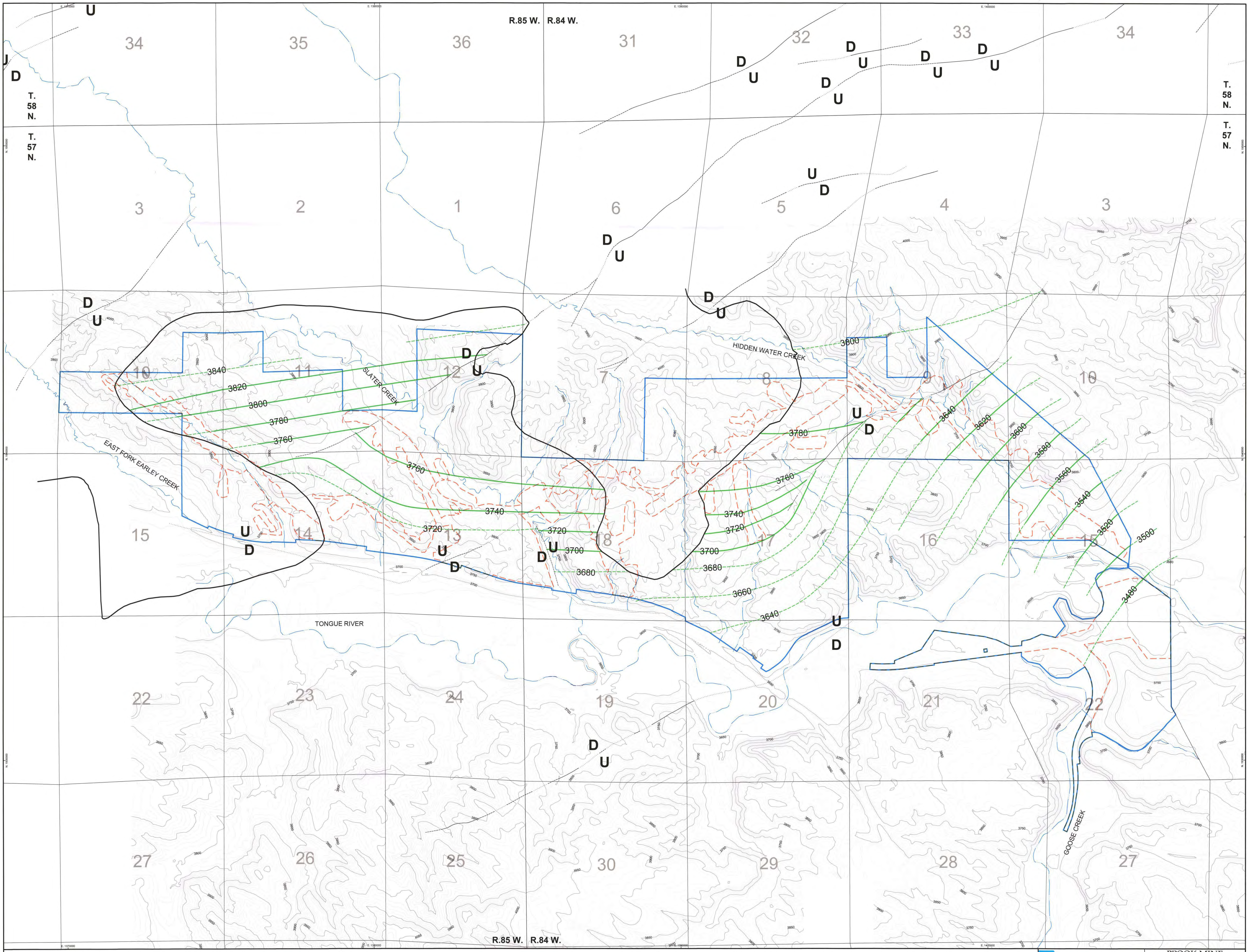
TFN 6 2/025
REC'D 10-25-18

POSTMINE STREAM PROFILES

Drawn By: DCJ
Checked By: JGB
Date: 10/14/14

WWC ENGINEERING
www.wwcengineering.com

FILE: RP-8-2_PM_PROFILES.dwg



LEGEND

- BROOK MINE PERMIT BOUNDARY
- AFFECTED AREA BOUNDARY
- POTENTIOMETRIC CONTOUR
- POTENTIOMETRIC CONTOUR (INFERRED)
- D / U FAULT LOCATION - APPROXIMATE
- FAULT LOCATION - INFERRED
- FAULT LOCATION - CONCEALED
- EDGE OF SATURATION ZONE OF COAL SEAM

CERTIFICATE OF ENGINEER

I, Jeffrey G. Barron, hereby certify that this drawing was prepared by myself or by engineers under my direct supervision and that it correctly represents the conditions described in the accompanying application which is designed to meet the requirements of the Wyoming Environmental Quality Act and its accompanying regulations.

Professional Engineer (Civil)
JEFFREY G. BARRON
13033
DATE 9/20/2019
WYOMING

GRAPHIC SCALE (FEET)
C.I. = 10'

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY

1101 SUGARVIEW DR. STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description
06/15	ROUND 1 COMMENTS
10/15	ROUND 2 COMMENTS
08/18	ROUND 7 COMMENTS
09/19	ROUND 10 COMMENTS

EXHIBIT RP.8-3

TFN 6 2/025
RECD 09-20-19

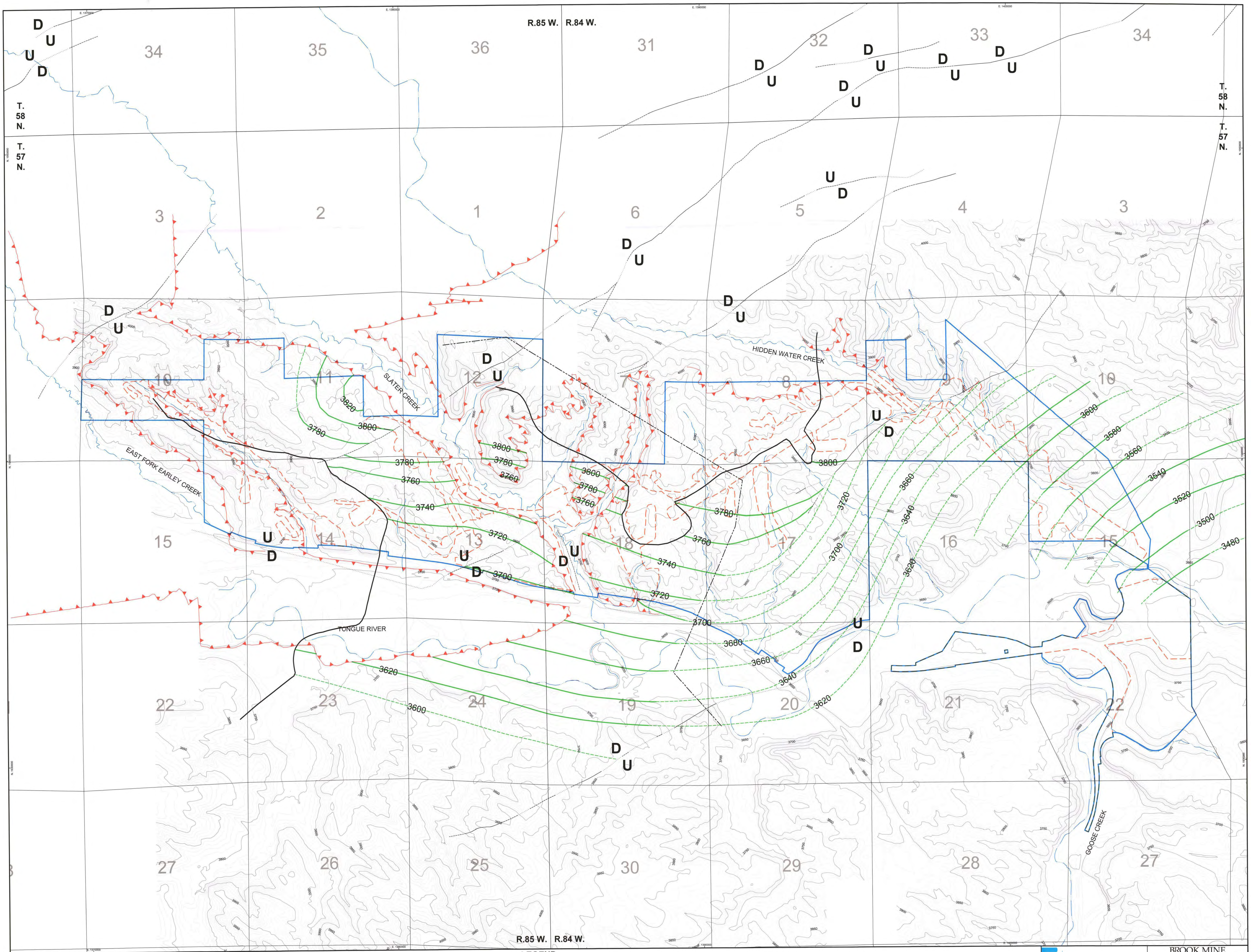
MASTERS SEAM
POSTMINE POTENTIOMETRY

Drawn By: CIG
Checked By: JGB
Date: 11/1/14

WWC ENGINEERING
www.wwcengineering.com

FILE: RP-8-3_MASTER_POST_POT.dwg

K:\Sheridan\RAMACO\13139\ACAD_WY83EC\DWGS\DWGS_REC_PLAN\ROUND_10_COMMENTS\RP-8-3_MASTER_POST_POT.dwg 9/20/2019 1:03:38 PM dave johnson



LEGEND

- BROOK MINE PERMIT BOUNDARY
- AFFECTED AREA BOUNDARY
- POTENTIOMETRIC CONTOUR
- POTENTIOMETRIC CONTOUR (INFERRED)
- FAULT LOCATION - INFERRED
- FAULT LOCATION - CONCEALED
- EDGE OF SATURATION ZONE OF COAL SEAM
- APPROXIMATE LOCATION OF CARNEY SPLIT
- APPROXIMATE OUTCROP LINE
- D / U FAULT LOCATION - APPROXIMATE

CERTIFICATE OF ENGINEER

I, Jeffrey G. Barron, hereby certify that this drawing was prepared by myself or by engineers under my direct supervision and that it correctly represents the conditions described in the accompanying application which is designed to meet the requirements of the Wyoming Environmental Quality Act and its accompanying regulations.

Professional Engineer (Civil)
JEFFREY G. BARRON
13033
DATE 9/20/2019
WYOMING

N

0 500 1,000 1,500 2,000
GRAPHIC SCALE (FEET)
C.I. = 10'

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY
1101 SUGARVIEW DR. STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description
06/15	ROUND 1 COMMENTS
10/15	ROUND 2 COMMENTS
08/18	ROUND 7 COMMENTS
09/19	ROUND 10 COMMENTS

EXHIBIT RP.8-4

TFN 6 2/025
RECD 09-20-19

CARNEY SEAM
POSTMINE POTENTIOMETRY

Drawn By: CIG
Checked By: JGB
Date: 11/1/14

WWC ENGINEERING
www.wwcengineering.com

FILE: RP-8-4_CARNEY_POST_POT.dwg

K:\Sheridan\RAMACO\13139\ACAD_WY83EC\DWGS\DWGS_REC_PLAN\ROUND_10_COMMENTS\RP-8-4_CARNEY_POST_POT.dwg 9/20/2019 1:02:43 PM dave johnson

LEGEND

(solid line)	BROOK MINE PERMIT BOUNDARY	578409-MST-UB	UNDERBURDEN MONITOR WELL
(dashed line)	AFFECTED AREA BOUNDARY	578415-CRN-MST	COAL MONITOR WELL
		578418-AL	ALLUVIAL MONITOR WELL
		578524-AL	ALLUVIAL MONITOR WELL (PROPOSED)
			SPOIL WELL (PROPOSED)
		SM578522-SW-1	SURFACE WATER MONITORING STATION
		578514-TR-1	SURFACE WATER MONITORING STATION (PROPOSED)
		578415-SPL-2	OVERBURDEN MONITOR WELL
		BH 371	BIG HORN COAL HISTORIC ALLUVIAL WELL

DEQ Ex. 6-113

CERTIFICATE OF ENGINEER

I, Jeffrey G. Barron, hereby certify that this drawing was prepared by myself or by engineers under my direct supervision and that it correctly represents the conditions described in the accompanying application which is designed to meet the requirements of the Wyoming Environmental Quality Act and its accompanying regulations.

Professional Engineer (Civil) JEFFREY G. BARRON 13033 WYOMING
DATE 9/20/2019

0 500 1,000 1,500 2,000
GRAPHIC SCALE (FEET)
C.I. = AS SHOWN

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY
1101 SUGARVIEW DR. STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description
06/15	ROUND 1 COMMENTS
10/15	ROUND 2 COMMENTS
12/15	ROUND 3 COMMENTS
08/18	ROUND 7 COMMENTS
02/19	ROUND 8 COMMENTS
04/19	ROUND 9 COMMENTS
06/19	ROUND 10 COMMENTS

EXHIBIT RP.8-5

TFN 6 2/025
RECD 09-20-19

POSTMINE HYDROLOGIC MONITORING LOCATIONS

Drawn By: DCJ
Checked By: JGB
Date: 11/1/14

WWC ENGINEERING
www.wwcengineering.com

FILE: RP-8-5_PM_MON_WELL_LOCS.dwg

K:\Sheridan\RAMACO\13139\ACAD_WY83EC\DWGS\DWGS_REC_PLAN\ROUND_10_COMMENTS\RP-8-5_PM_MON_WELL_LOCS.dwg 9/20/2019 1:14:56 PM dave johnson

ADDENDUM RP-1

HEC-HMS Inputs and Results

HEC-HMS INPUTS

```
Basin: Sheridan_Mine
     Last Modified Date: 30 September 2014
     Last Modified Time: 14:48:19
     Version: 4.0
     Filepath Separator: \
     Unit System: English
     Missing Flow To Zero: No
     Enable Flow Ratio: No
     Compute Local Flow At Junctions: No

     Enable Sediment Routing: No

     Enable Quality Routing: No
End:

Subbasin: SCSBranch
     Canvas X: -7504.761904761905
     Canvas Y: 3895.2380952380954
     Label X: -19.0
     Label Y: 20.0
     Area: 3.71
     Downstream: SCBRANCH_R

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 79
     Initial Abstraction: 0

     Transform: SCS
     Lag: 153.7
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: SCNBranch
     Canvas X: -5409.523809523809
     Canvas Y: 4504.761904761905
     Area: 2.40
     Downstream: SCBRANCH_R

     Canopy: None
     Plant Uptake Method: None
```

```
     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 79
     Initial Abstraction: 0

     Transform: SCS
     Lag: 108.8
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: SCBRANCH_R
     Canvas X: -5504.761904761905
     Canvas Y: 1952.3809523809523
     From Canvas X: -6304.761904761905
     From Canvas Y: 3552.3809523809523
     Downstream: SC3_R

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 12676
     Energy Slope: 0.011
     Width: 30
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: SC3
     Canvas X: -6742.857142857143
     Canvas Y: 2047.6190476190477
     Label X: -1.0
     Label Y: -2.0
     Area: 2.95
     Downstream: SC3_R

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 79
     Initial Abstraction: 0
```

```
     Transform: SCS
     Lag: 117.8
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: SC3_R
     Canvas X: -4438.095238095238
     Canvas Y: 1019.0476190476184
     From Canvas X: -5504.761904761905
     From Canvas Y: 1952.3809523809523
     Downstream: SC2_R

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 10310
     Energy Slope: 0.0097
     Width: 30
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: SC2
     Canvas X: -6190.476190476191
     Canvas Y: 657.1428571428569
     Area: 3.81
     Downstream: SC2_R

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 79
     Initial Abstraction: 0

     Transform: SCS
     Lag: 119.5
     Unitgraph Type: STANDARD

     Baseflow: None
End:
```

```
Reach: SC2_R
     Canvas X: -1980.9523809523807
     Canvas Y: -1285.7142857142862
     From Canvas X: -4438.095238095238
     From Canvas Y: 1019.0476190476184
     Downstream: SC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 23923
     Energy Slope: 0.0071
     Width: 50
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: SC1
     Canvas X: -3161.9047619047615
     Canvas Y: -1800.0
     Area: 1.96
     Downstream: SC_Out

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 79
     Initial Abstraction: 0

     Transform: SCS
     Lag: 214.3
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: SCSub1
     Canvas X: -52.21932114882475
     Canvas Y: 2571.8015665796347
     Area: 0.42
     Downstream: SCS1_R

     Canopy: None
     Plant Uptake Method: None
```

```
     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 76
     Initial Abstraction: 0

     Transform: SCS
     Lag: 46.0
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: SCS1_R
     Canvas X: -1980.9523809523807
     Canvas Y: -1285.7142857142862
     From Canvas X: -571.4285714285716
     From Canvas Y: 1704.7619047619046
     Label X: 1.0
     Label Y: 38.0
     Downstream: SC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 4555
     Energy Slope: 0.0110
     Width: 50
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: SCSub2
     Canvas X: -1600.0
     Canvas Y: 2657.142857142857
     Area: 0.41
     Downstream: SCS2_R

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 75
```

```
     Initial Abstraction: 0

     Transform: SCS
     Lag: 30.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: SCS2_R
     Canvas X: -1980.9523809523807
     Canvas Y: -1285.7142857142862
     From Canvas X: -1771.4285714285716
     From Canvas Y: 1857.1428571428569
     Label X: -26.0
     Label Y: 22.0
     Downstream: SC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 7487
     Energy Slope: 0.0087
     Width: 50
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: SCSub4
     Canvas X: -6171.428571428572
     Canvas Y: -504.7619047619046
     Label X: -2.0
     Label Y: 0.0
     Area: 0.34
     Downstream: SCS4_R

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 84
     Initial Abstraction: 0

     Transform: SCS
     Lag: 40.6
```

```
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: SCS4_R
     Canvas X: -1980.9523809523807
     Canvas Y: -1285.7142857142862
     From Canvas X: -4971.428571428572
     From Canvas Y: -314.2857142857147
     Label X: -42.0
     Label Y: -14.0
     Downstream: SC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 18990
     Energy Slope: 0.0076
     Width: 50
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: SCSub3
     Canvas X: -3159.2689295039163
     Canvas Y: 2597.911227154047
     Area: 0.31
     Downstream: SCS3_R

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 76
     Initial Abstraction: 0

     Transform: SCS
     Lag: 39.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: SCS3_R
```

```
     Canvas X: -1980.9523809523807
     Canvas Y: -1285.7142857142862
     From Canvas X: -2990.476190476191
     From Canvas Y: 1914.2857142857142
     Label X: -35.0
     Label Y: 1.0
     Downstream: SC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 13461
     Energy Slope: 0.0074
     Width: 50
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: SCSub5
     Canvas X: 476.19047619047706
     Canvas Y: 1323.8095238095239
     Area: 0.14
     Downstream: SCS5_R

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 75
     Initial Abstraction: 0

     Transform: SCS
     Lag: 28.3
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: SCS5_R
     Canvas X: -1980.9523809523807
     Canvas Y: -1285.7142857142862
     From Canvas X: -228.57142857142844
     From Canvas Y: 542.8571428571431
     Label X: -12.0
     Label Y: 5.0
```

```
     Downstream: SC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 1166
     Energy Slope: 0.0214
     Width: 50
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Junction: SC_Out
     Canvas X: -1980.9523809523807
     Canvas Y: -1285.7142857142862
     Label X: 0.0
     Label Y: 1.0
     Downstream: TONGUE_RIVER
End:

Subbasin: EF EC
     Canvas X: -7662.60162601626
     Canvas Y: -2947.1544715447153
     Label X: 13.0
     Label Y: -5.0
     Area: 1.84
     Downstream: TONGUE_RIVER

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 87
     Initial Abstraction: 0

     Transform: SCS
     Lag: 119.6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: TRD5
     Canvas X: -6585.365853658536
     Canvas Y: -2398.373983739837
```

```
     Area: 0.93
     Downstream: TONGUE_RIVER

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 83
     Initial Abstraction: 0

     Transform: SCS
     Lag: 62.1
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: TRD3
     Canvas X: 345.5284552845533
     Canvas Y: -1260.162601626016
     Area: 0.59
     Downstream: TONGUE_RIVER

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 71
     Initial Abstraction: 0

     Transform: SCS
     Lag: 76.0
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: TR_Sub1
     Canvas X: 2036.5535248041779
     Canvas Y: -1292.4281984334202
     Label X: 2.0
     Label Y: -5.0
     Area: 0.52
```

```
     Downstream: TONGUE_RIVER

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 74
     Initial Abstraction: 0

     Transform: SCS
     Lag: 36.7
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: TRD2
     Canvas X: 443.8642297650131
     Canvas Y: -1919.0600522193208
     Area: 0.51
     Downstream: TONGUE_RIVER

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 74
     Initial Abstraction: 0

     Transform: SCS
     Lag: 70.4
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: TRD4
     Canvas X: -5284.552845528455
     Canvas Y: -1849.5934959349588
     Area: 0.27
     Downstream: TONGUE_RIVER

     Canopy: None
```

```
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 83
     Initial Abstraction: 0

     Transform: SCS
     Lag: 35.6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: TR_Sub2
     Canvas X: 1749.3472584856409
     Canvas Y: -1997.3890339425589
     Label X: 3.0
     Label Y: 1.0
     Area: 0.24
     Downstream: TONGUE_RIVER

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 72
     Initial Abstraction: 0

     Transform: SCS
     Lag: 71.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: TRD1
     Canvas X: -447.1544715447153
     Canvas Y: -650.4065040650403
     Label X: 4.0
     Label Y: 1.0
     Area: 0.03
     Downstream: TONGUE_RIVER
```

```
     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 72
     Initial Abstraction: 0

     Transform: SCS
     Lag: 15.0
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: TONGUE_RIVER
     Canvas X: -894.3089430894306
     Canvas Y: -4146.341463414634
End:

Subbasin: HWC3
     Canvas X: 438.0952380952385
     Canvas Y: 4200.0
     Area: 3.29
     Downstream: HWCUpper

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 76
     Initial Abstraction: 0

     Transform: SCS
     Lag: 126.0
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: HWCUpper
     Canvas X: 2012.1951219512193
     Canvas Y: 2399.6515679442505
     From Canvas X: 457.1428571428569
```

```
     From Canvas Y: 3761.904761904762
     Label X: -22.0
     Label Y: 18.0
     Downstream: HWCLower

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 12103
     Energy Slope: 0.0112
     Width: 20
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: HWC2
     Canvas X: 2628.5714285714294
     Canvas Y: 3076.190476190476
     Area: 3.19
     Downstream: HWCLower

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 76
     Initial Abstraction: 0

     Transform: SCS
     Lag: 124.1
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: HWCLower
     Canvas X: 5295.238095238095
     Canvas Y: -904.7619047619046
     From Canvas X: 2012.1951219512193
     From Canvas Y: 2399.6515679442505
     Downstream: HWC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 12446
```

```
     Energy Slope: 0.0145
     Width: 25
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: HWC1
     Canvas X: 4152.380952380952
     Canvas Y: -1476.1904761904761
     Label X: 3.0
     Label Y: -2.0
     Area: 0.81
     Downstream: HWC_Out

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 76
     Initial Abstraction: 0

     Transform: SCS
     Lag: 109.6
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Subbasin: HWCSub1
     Canvas X: 1142.8571428571431
     Canvas Y: 238.09523809523762
     Area: 0.19
     Downstream: HWCS1_R

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 76
     Initial Abstraction: 0
```

```
     Transform: SCS
     Lag: 27.0
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: HWCS1_R
     Canvas X: 5295.238095238095
     Canvas Y: -904.7619047619046
     From Canvas X: 2247.6190476190477
     From Canvas Y: 180.95238095238074
     Downstream: HWC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 9457
     Energy Slope: 0.0143
     Width: 25
     Side Slope: 4
     Mannings n: 0.03
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: HWCSub4
     Canvas X: 5752.380952380952
     Canvas Y: 3819.0476190476193
     Area: 0.18
     Downstream: HWCS4_R

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 75
     Initial Abstraction: 0

     Transform: SCS
     Lag: 34.8
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: HWCS4_R
```

```
    Canvas X: 5295.238095238095
    Canvas Y: -904.7619047619046
    From Canvas X: 5447.619047619048
    From Canvas Y: 3057.142857142857
    Downstream: HWC_Out

    Route: Muskingum Cunge
    Channel: Trapezoid
    Length: 8891
    Energy Slope: 0.0141
    Width: 25
    Side Slope: 4
    Mannings n: 0.030
    Use Variable Time Step: No
    Channel Loss: None
End:

Subbasin: HWCSub2
    Canvas X: 7310.70496083551
    Canvas Y: 1031.3315926892951
    Area: 0.14
    Downstream: HWCS2_R

    Canopy: None
    Plant Uptake Method: None

    Surface: None

    LossRate: SCS
    Percent Impervious Area: 0.0
    Curve Number: 77
    Initial Abstraction: 0

    Transform: SCS
    Lag: 21.1
    Unitgraph Type: STANDARD

    Baseflow: None
End:

Reach: HWCS2_R
    Canvas X: 5295.238095238095
    Canvas Y: -904.7619047619046
    From Canvas X: 6380.952380952382
    From Canvas Y: 180.95238095238074
    Downstream: HWC_Out

    Route: Muskingum Cunge
    Channel: Trapezoid
```

```
     Length: 6902
     Energy Slope: 0.0145
     Width: 25
     Side Slope: 4
     Mannings n: 0.030
     Use Variable Time Step: No
     Channel Loss: None
End:

Subbasin: HWCSub5
     Canvas X: 3695.2380952380954
     Canvas Y: 4428.571428571428
     Area: 0.12
     Downstream: HWCS5_R

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 76
     Initial Abstraction: 0

     Transform: SCS
     Lag: 19.7
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: HWCS5_R
     Canvas X: 5295.238095238095
     Canvas Y: -904.7619047619046
     From Canvas X: 4209.523809523809
     From Canvas Y: 3838.095238095238
     Downstream: HWC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 11440
     Energy Slope: 0.0144
     Width: 25
     Side Slope: 4
     Mannings n: 0.030
     Use Variable Time Step: No
     Channel Loss: None
End:
```

```
Subbasin: HWCSub3
     Canvas X: 6476.190476190477
     Canvas Y: 2752.3809523809523
     Area: 0.07
     Downstream: HWCS3_R

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 76
     Initial Abstraction: 0

     Transform: SCS
     Lag: 25.9
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Reach: HWCS3_R
     Canvas X: 5295.238095238095
     Canvas Y: -904.7619047619046
     From Canvas X: 5980.952380952382
     From Canvas Y: 2009.5238095238096
     Downstream: HWC_Out

     Route: Muskingum Cunge
     Channel: Trapezoid
     Length: 8013
     Energy Slope: 0.0144
     Width: 25
     Side Slope: 4
     Mannings n: 0.030
     Use Variable Time Step: No
     Channel Loss: None
End:

Junction: HWC_Out
     Canvas X: 5295.238095238095
     Canvas Y: -904.7619047619046
End:

Subbasin: GC1
     Canvas X: 6422.764227642276
```

```
     Canvas Y: -3821.1382113821146
     Area: 0.34
     Downstream: GOOSE_CREEK

     Canopy: None
     Plant Uptake Method: None

     Surface: None

     LossRate: SCS
     Percent Impervious Area: 0.0
     Curve Number: 81
     Initial Abstraction: 0

     Transform: SCS
     Lag: 55.8
     Unitgraph Type: STANDARD

     Baseflow: None
End:

Junction: GOOSE_CREEK
     Canvas X: 4796.747967479674
     Canvas Y: -3211.382113821139
End:

Basin Schematic Properties:
     Last View N: 5000.0
     Last View S: -5000.0
     Last View W: -5000.0
     Last View E: 5000.0
     Maximum View N: 5000.0
     Maximum View S: -5000.0
     Maximum View W: -5000.0
     Maximum View E: 5000.0
     Extent Method: Elements
     Buffer: 0
     Draw Icons: Yes
     Draw Icon Labels: Name
     Draw Map Objects: No
     Draw Gridlines: No
     Draw Flow Direction: No
     Fix Element Locations: No
     Fix Hydrologic Order: No
End:
```

HEC-HMS RESULTS

2-year, 6-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	95.7	01Jun2014, 14:27	33.3
GC1	0.34	21.1	01Jun2014, 13:18	4.6
GOOSE_CREEK	0.34	21.1	01Jun2014, 13:18	4.6
HWCLower	6.48	193.9	01Jun2014, 15:12	68.9
HWCSub1	0.19	15.1	01Jun2014, 12:48	2.0
HWCSub2	0.14	13.4	01Jun2014, 12:45	1.6
HWCSub3	0.07	5.7	01Jun2014, 12:48	0.8
HWCSub4	0.18	11.8	01Jun2014, 12:57	1.9
HWCSub5	0.12	11.5	01Jun2014, 12:42	1.3
HWCS1_R	0.19	15.1	01Jun2014, 13:30	2.1
HWCS2_R	0.14	13.3	01Jun2014, 13:15	1.6
HWCS3_R	0.07	5.7	01Jun2014, 13:42	0.8
HWCS4_R	0.18	11.7	01Jun2014, 13:42	1.9
HWCS5_R	0.12	14.2	01Jun2014, 13:39	1.3
HWCUpper	3.29	99.8	01Jun2014, 15:03	35.0
HWC_Out	7.99	229.5	01Jun2014, 15:00	85.2
HWC1	0.81	27.0	01Jun2014, 14:18	8.7
HWC2	3.19	97.8	01Jun2014, 14:33	33.9
HWC3	3.29	99.9	01Jun2014, 14:33	35.0
SCBRANCH_R	6.11	197.4	01Jun2014, 15:03	74.1
SCNBranch	2.40	90.5	01Jun2014, 14:18	29.2
SCSBranch	3.71	113.0	01Jun2014, 15:00	44.9
SCSub1	0.42	23.8	01Jun2014, 13:09	4.5
SCSub2	0.41	28.9	01Jun2014, 12:54	4.2
SCSub3	0.31	19.3	01Jun2014, 13:03	3.3
SCSub4	0.34	29.7	01Jun2014, 13:03	5.3
SCSub5	0.14	10.4	01Jun2014, 12:51	1.4
SCS1_R	0.42	23.8	01Jun2014, 13:33	4.5
SCS2_R	0.41	28.7	01Jun2014, 13:33	4.2
SCS3_R	0.31	20.0	01Jun2014, 14:27	3.4
SCS4_R	0.34	28.7	01Jun2014, 14:51	5.3
SCS5_R	0.14	10.4	01Jun2014, 12:57	1.4
SC_Out	16.45	499.9	01Jun2014, 15:42	198.8
SC1	1.96	48.4	01Jun2014, 15:45	23.9
SC2	3.81	135.1	01Jun2014, 14:27	46.1
SC2_R	12.87	419.7	01Jun2014, 15:48	156.0
SC3	2.95	105.9	01Jun2014, 14:27	35.8
SC3_R	9.06	296.7	01Jun2014, 15:09	109.9
TONGUE_RIVER	21.38	593.4	01Jun2014, 15:21	267.6
TRD1	0.03	2.8	01Jun2014, 12:39	0.3
TRD2	0.51	20.3	01Jun2014, 13:36	5.0
TRD3	0.59	19.9	01Jun2014, 13:42	5.2
TRD4	0.27	24.5	01Jun2014, 12:57	4.0
TRD5	0.93	58.8	01Jun2014, 13:27	13.7
TR_Sub1	0.52	31.5	01Jun2014, 13:00	5.1
TR_Sub2	0.24	8.7	01Jun2014, 13:39	2.2

2-year, 24-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	194.2	01Jun2014, 22:00	73.7
GC1	0.34	48.4	01Jun2014, 20:51	10.6
GOOSE_CREEK	0.34	48.4	01Jun2014, 20:51	10.6
HWCLower	6.48	407.5	01Jun2014, 22:39	167.0
HWCSub1	0.19	36.5	01Jun2014, 20:21	4.9
HWCSub2	0.14	32.8	01Jun2014, 20:15	3.7
HWCSub3	0.07	13.8	01Jun2014, 20:18	1.8
HWCSub4	0.18	28.0	01Jun2014, 20:27	4.5
HWCSub5	0.12	28.2	01Jun2014, 20:12	3.1
HWCS1_R	0.19	36.4	01Jun2014, 20:51	4.9
HWCS2_R	0.14	32.5	01Jun2014, 20:39	3.8
HWCS3_R	0.07	13.8	01Jun2014, 20:57	1.8
HWCS4_R	0.18	28.0	01Jun2014, 21:00	4.5
HWCS5_R	0.12	27.3	01Jun2014, 20:57	3.1
HWCUpper	3.29	209.1	01Jun2014, 22:33	84.8
HWC_Out	7.99	474.9	01Jun2014, 22:30	205.9
HWC1	0.81	57.2	01Jun2014, 21:51	20.9
HWC2	3.19	205.1	01Jun2014, 22:06	82.2
HWC3	3.29	209.2	01Jun2014, 22:09	84.8
SCBRANCH_R	6.11	400.7	01Jun2014, 22:33	176.3
SCNBranch	2.40	191.9	01Jun2014, 21:51	69.3
SCSBranch	3.71	228.8	01Jun2014, 22:39	107.1
SCSub1	0.42	55.9	01Jun2014, 20:42	10.8
SCSub2	0.41	69.4	01Jun2014, 20:24	10.2
SCSub3	0.31	45.7	01Jun2014, 20:33	8.0
SCSub4	0.34	69.1	01Jun2014, 20:33	12.0
SCSub5	0.14	25.2	01Jun2014, 20:21	3.5
SCS1_R	0.42	55.9	01Jun2014, 20:57	10.8
SCS2_R	0.41	68.8	01Jun2014, 20:51	10.2
SCS3_R	0.31	45.4	01Jun2014, 21:36	8.0
SCS4_R	0.34	73.4	01Jun2014, 21:45	12.0
SCS5_R	0.14	25.1	01Jun2014, 20:27	3.5
SC_Out	16.45	1021.6	01Jun2014, 23:06	472.5
SC1	1.96	94.0	01Jun2014, 23:48	56.6
SC2	3.81	284.0	01Jun2014, 22:03	110.0
SC2_R	12.87	870.6	01Jun2014, 23:09	371.4
SC3	2.95	222.3	01Jun2014, 22:00	85.1
SC3_R	9.06	608.8	01Jun2014, 22:39	261.5
TONGUE_RIVER	21.38	1253.5	01Jun2014, 22:54	630.1
TRD1	0.03	7.1	01Jun2014, 20:09	0.7
TRD2	0.51	46.2	01Jun2014, 21:09	12.2
TRD3	0.59	45.1	01Jun2014, 21:15	12.7
TRD4	0.27	57.6	01Jun2014, 20:30	9.1
TRD5	0.93	133.4	01Jun2014, 20:57	31.5
TR_Sub1	0.52	75.2	01Jun2014, 20:30	12.4
TR_Sub2	0.24	19.9	01Jun2014, 21:09	5.3

5-year, 6-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	171.0	01Jun2014, 14:24	60.7
GC1	0.34	39.2	01Jun2014, 13:18	8.7
GOOSE_CREEK	0.34	39.2	01Jun2014, 13:18	8.7
HWCLower	6.48	373.9	01Jun2014, 15:03	133.5
HWCSub1	0.19	28.9	01Jun2014, 12:48	4.0
HWCSub2	0.14	25.4	01Jun2014, 12:45	3.0
HWCSub3	0.07	11.0	01Jun2014, 12:48	1.5
HWCSub4	0.18	22.6	01Jun2014, 12:57	3.6
HWCSub5	0.12	21.9	01Jun2014, 12:42	2.5
HWCS1_R	0.19	28.8	01Jun2014, 13:24	4.0
HWCS2_R	0.14	25.4	01Jun2014, 13:09	3.0
HWCS3_R	0.07	10.9	01Jun2014, 13:30	1.5
HWCS4_R	0.18	22.5	01Jun2014, 13:33	3.6
HWCS5_R	0.12	22.3	01Jun2014, 13:24	2.5
HWCUpper	3.29	191.3	01Jun2014, 14:57	67.8
HWC_Out	7.99	442.3	01Jun2014, 14:54	165.0
HWC1	0.81	51.7	01Jun2014, 14:18	16.9
HWC2	3.19	187.3	01Jun2014, 14:33	65.7
HWC3	3.29	191.4	01Jun2014, 14:33	67.7
SCBRANCH_R	6.11	373.6	01Jun2014, 14:54	141.7
SCNBranch	2.40	170.7	01Jun2014, 14:15	55.8
SCSBranch	3.71	213.7	01Jun2014, 15:00	85.9
SCSub1	0.42	45.6	01Jun2014, 13:09	8.8
SCSub2	0.41	55.4	01Jun2014, 12:54	8.2
SCSub3	0.31	36.9	01Jun2014, 13:03	6.5
SCSub4	0.34	54.2	01Jun2014, 13:03	9.8
SCSub5	0.14	20.0	01Jun2014, 12:51	2.8
SCS1_R	0.42	45.5	01Jun2014, 13:27	8.8
SCS2_R	0.41	55.1	01Jun2014, 13:24	8.2
SCS3_R	0.31	36.6	01Jun2014, 14:09	6.5
SCS4_R	0.34	54.4	01Jun2014, 14:21	9.8
SCS5_R	0.14	19.9	01Jun2014, 12:57	2.8
SC_Out	16.45	950.6	01Jun2014, 15:24	380.2
SC1	1.96	92.0	01Jun2014, 15:42	45.7
SC2	3.81	255.2	01Jun2014, 14:27	88.1
SC2_R	12.87	802.9	01Jun2014, 15:33	298.4
SC3	2.95	200.0	01Jun2014, 14:24	68.5
SC3_R	9.06	564.1	01Jun2014, 15:00	210.2
TONGUE_RIVER	21.38	1156.2	01Jun2014, 15:06	509.0
TRD1	0.03	5.4	01Jun2014, 12:39	0.5
TRD2	0.51	39.2	01Jun2014, 13:36	9.8
TRD3	0.59	38.9	01Jun2014, 13:42	10.2
TRD4	0.27	45.1	01Jun2014, 12:57	7.5
TRD5	0.93	108.0	01Jun2014, 13:24	25.7
TR_Sub1	0.52	60.7	01Jun2014, 13:00	10.0
TR_Sub2	0.24	17.0	01Jun2014, 13:36	4.3

5-year, 24-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	298.3	01Jun2014, 22:00	112.3
GC1	0.34	77.0	01Jun2014, 20:51	16.7
GOOSE_CREEK	0.34	77.0	01Jun2014, 20:51	16.7
HWCLower	6.48	663.0	01Jun2014, 22:33	268.0
HWCSub1	0.19	59.3	01Jun2014, 20:21	7.9
HWCSub2	0.14	53.0	01Jun2014, 20:15	6.0
HWCSub3	0.07	22.5	01Jun2014, 20:18	2.9
HWCSub4	0.18	45.7	01Jun2014, 20:27	7.2
HWCSub5	0.12	45.9	01Jun2014, 20:12	5.0
HWCS1_R	0.19	59.0	01Jun2014, 20:45	7.9
HWCS2_R	0.14	52.7	01Jun2014, 20:33	6.0
HWCS3_R	0.07	22.4	01Jun2014, 20:51	2.9
HWCS4_R	0.18	45.6	01Jun2014, 20:54	7.2
HWCS5_R	0.12	45.4	01Jun2014, 20:48	5.0
HWCUpper	3.29	339.0	01Jun2014, 22:30	136.1
HWC_Out	7.99	772.6	01Jun2014, 22:27	330.5
HWC1	0.81	92.7	01Jun2014, 21:51	33.5
HWC2	3.19	332.7	01Jun2014, 22:06	131.9
HWC3	3.29	339.2	01Jun2014, 22:09	136.1
SCBRANCH_R	6.11	642.4	01Jun2014, 22:30	279.8
SCNBranch	2.40	307.7	01Jun2014, 21:48	109.9
SCSBranch	3.71	366.7	01Jun2014, 22:39	169.9
SCSub1	0.42	90.9	01Jun2014, 20:39	17.4
SCSub2	0.41	113.1	01Jun2014, 20:24	16.4
SCSub3	0.31	74.3	01Jun2014, 20:33	12.8
SCSub4	0.34	108.4	01Jun2014, 20:33	18.6
SCSub5	0.14	41.0	01Jun2014, 20:21	5.6
SCS1_R	0.42	90.8	01Jun2014, 20:54	17.4
SCS2_R	0.41	112.5	01Jun2014, 20:48	16.4
SCS3_R	0.31	73.6	01Jun2014, 21:27	12.8
SCS4_R	0.34	107.4	01Jun2014, 21:36	18.6
SCS5_R	0.14	40.8	01Jun2014, 20:24	5.6
SC_Out	16.45	1636.8	01Jun2014, 22:57	750.0
SC1	1.96	150.4	01Jun2014, 23:48	89.8
SC2	3.81	455.3	01Jun2014, 22:00	174.5
SC2_R	12.87	1405.3	01Jun2014, 23:00	589.4
SC3	2.95	356.3	01Jun2014, 22:00	135.1
SC3_R	9.06	979.5	01Jun2014, 22:33	414.9
TONGUE_RIVER	21.38	2024.2	01Jun2014, 22:45	995.9
TRD1	0.03	11.6	01Jun2014, 20:09	1.1
TRD2	0.51	75.5	01Jun2014, 21:06	19.7
TRD3	0.59	74.4	01Jun2014, 21:15	20.7
TRD4	0.27	90.7	01Jun2014, 20:30	14.2
TRD5	0.93	210.1	01Jun2014, 20:57	49.0
TR_Sub1	0.52	123.0	01Jun2014, 20:30	20.1
TR_Sub2	0.24	32.7	01Jun2014, 21:09	8.7

10-year, 6-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	225.6	01Jun2014, 14:24	80.9
GC1	0.34	52.9	01Jun2014, 13:18	11.8
GOOSE_CREEK	0.34	52.9	01Jun2014, 13:18	11.8
HWCLower	6.48	513.6	01Jun2014, 15:00	184.2
HWCSub1	0.19	39.6	01Jun2014, 12:48	5.5
HWCSub2	0.14	34.7	01Jun2014, 12:45	4.2
HWCSub3	0.07	15.0	01Jun2014, 12:48	2.0
HWCSub4	0.18	31.0	01Jun2014, 12:57	5.0
HWCSub5	0.12	30.0	01Jun2014, 12:42	3.5
HWCS1_R	0.19	39.3	01Jun2014, 13:18	5.5
HWCS2_R	0.14	34.6	01Jun2014, 13:06	4.2
HWCS3_R	0.07	14.9	01Jun2014, 13:24	2.0
HWCS4_R	0.18	30.9	01Jun2014, 13:27	5.0
HWCS5_R	0.12	29.6	01Jun2014, 13:24	3.5
HWCUpper	3.29	262.3	01Jun2014, 14:54	93.5
HWC_Out	7.99	607.2	01Jun2014, 14:51	227.7
HWC1	0.81	70.8	01Jun2014, 14:18	23.3
HWC2	3.19	256.8	01Jun2014, 14:30	90.7
HWC3	3.29	262.4	01Jun2014, 14:33	93.5
SCBRANCH_R	6.11	508.4	01Jun2014, 14:54	194.2
SCNBranch	2.40	231.9	01Jun2014, 14:15	76.5
SCSBranch	3.71	290.9	01Jun2014, 14:57	117.6
SCSub1	0.42	62.4	01Jun2014, 13:09	12.1
SCSub2	0.41	75.9	01Jun2014, 12:54	11.4
SCSub3	0.31	50.5	01Jun2014, 13:03	8.9
SCSub4	0.34	72.2	01Jun2014, 13:03	13.3
SCSub5	0.14	27.5	01Jun2014, 12:51	3.9
SCS1_R	0.42	62.2	01Jun2014, 13:24	12.1
SCS2_R	0.41	75.5	01Jun2014, 13:21	11.4
SCS3_R	0.31	50.1	01Jun2014, 14:03	8.9
SCS4_R	0.34	71.6	01Jun2014, 14:15	13.3
SCS5_R	0.14	27.4	01Jun2014, 12:54	3.9
SC_Out	16.45	1295.7	01Jun2014, 15:18	521.0
SC1	1.96	125.6	01Jun2014, 15:42	62.6
SC2	3.81	346.9	01Jun2014, 14:27	120.8
SC2_R	12.87	1096.7	01Jun2014, 15:27	408.8
SC3	2.95	271.8	01Jun2014, 14:24	93.8
SC3_R	9.06	769.0	01Jun2014, 14:57	288.0
TONGUE_RIVER	21.38	1588.4	01Jun2014, 15:00	695.4
TRD1	0.03	7.5	01Jun2014, 12:39	0.7
TRD2	0.51	53.9	01Jun2014, 13:36	13.6
TRD3	0.59	53.9	01Jun2014, 13:42	14.2
TRD4	0.27	60.3	01Jun2014, 12:57	10.1
TRD5	0.93	144.7	01Jun2014, 13:24	34.8
TR_Sub1	0.52	83.4	01Jun2014, 13:00	13.9
TR_Sub2	0.24	23.5	01Jun2014, 13:36	6.0

10-year, 24-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	375.8	01Jun2014, 22:00	141.0
GC1	0.34	99.0	01Jun2014, 20:51	21.3
GOOSE_CREEK	0.34	99.0	01Jun2014, 20:51	21.3
HWCLower	6.48	863.3	01Jun2014, 22:30	346.5
HWCSub1	0.19	77.2	01Jun2014, 20:21	10.2
HWCSub2	0.14	68.8	01Jun2014, 20:15	7.7
HWCSub3	0.07	29.3	01Jun2014, 20:18	3.7
HWCSub4	0.18	59.7	01Jun2014, 20:27	9.3
HWCSub5	0.12	59.7	01Jun2014, 20:12	6.4
HWCS1_R	0.19	76.8	01Jun2014, 20:45	10.2
HWCS2_R	0.14	68.5	01Jun2014, 20:33	7.7
HWCS3_R	0.07	29.1	01Jun2014, 20:48	3.8
HWCS4_R	0.18	59.5	01Jun2014, 20:54	9.3
HWCS5_R	0.12	59.1	01Jun2014, 20:45	6.4
HWCUpper	3.29	440.7	01Jun2014, 22:27	175.9
HWC_Out	7.99	1005.8	01Jun2014, 22:24	427.3
HWC1	0.81	120.6	01Jun2014, 21:51	43.3
HWC2	3.19	432.5	01Jun2014, 22:06	170.6
HWC3	3.29	441.0	01Jun2014, 22:09	175.9
SCBRANCH_R	6.11	829.6	01Jun2014, 22:27	359.3
SCNBranch	2.40	397.4	01Jun2014, 21:48	141.1
SCSBranch	3.71	473.3	01Jun2014, 22:39	218.2
SCSub1	0.42	118.3	01Jun2014, 20:39	22.5
SCSub2	0.41	147.6	01Jun2014, 20:24	21.2
SCSub3	0.31	96.7	01Jun2014, 20:33	16.6
SCSub4	0.34	138.1	01Jun2014, 20:33	23.5
SCSub5	0.14	53.5	01Jun2014, 20:21	7.3
SCS1_R	0.42	118.1	01Jun2014, 20:54	22.5
SCS2_R	0.41	146.7	01Jun2014, 20:45	21.3
SCS3_R	0.31	96.0	01Jun2014, 21:21	16.6
SCS4_R	0.34	136.8	01Jun2014, 21:33	23.5
SCS5_R	0.14	53.3	01Jun2014, 20:24	7.3
SC_Out	16.45	2113.1	01Jun2014, 22:51	963.3
SC1	1.96	194.1	01Jun2014, 23:45	115.3
SC2	3.81	588.0	01Jun2014, 22:00	224.1
SC2_R	12.87	1820.7	01Jun2014, 22:54	756.9
SC3	2.95	460.1	01Jun2014, 22:00	173.5
SC3_R	9.06	1266.9	01Jun2014, 22:30	532.8
TONGUE_RIVER	21.38	2620.0	01Jun2014, 22:39	1276.1
TRD1	0.03	15.2	01Jun2014, 20:09	1.4
TRD2	0.51	98.7	01Jun2014, 21:06	25.6
TRD3	0.59	97.7	01Jun2014, 21:12	27.0
TRD4	0.27	115.8	01Jun2014, 20:27	18.1
TRD5	0.93	268.5	01Jun2014, 20:57	62.3
TR_Sub1	0.52	160.8	01Jun2014, 20:30	26.1
TR_Sub2	0.24	42.8	01Jun2014, 21:09	11.3

25-year, 6-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	296.5	01Jun2014, 14:24	107.6
GC1	0.34	71.1	01Jun2014, 13:18	16.0
GOOSE_CREEK	0.34	71.1	01Jun2014, 13:18	16.0
HWCLower	6.48	703.6	01Jun2014, 14:57	254.0
HWCSub1	0.19	54.0	01Jun2014, 12:48	7.5
HWCSub2	0.14	47.1	01Jun2014, 12:45	5.7
HWCSub3	0.07	20.4	01Jun2014, 12:48	2.8
HWCSub4	0.18	42.4	01Jun2014, 12:57	6.9
HWCSub5	0.12	40.8	01Jun2014, 12:42	4.8
HWCS1_R	0.19	53.6	01Jun2014, 13:15	7.6
HWCS2_R	0.14	46.9	01Jun2014, 13:03	5.8
HWCS3_R	0.07	20.3	01Jun2014, 13:21	2.8
HWCS4_R	0.18	42.3	01Jun2014, 13:24	6.9
HWCS5_R	0.12	40.4	01Jun2014, 13:18	4.8
HWCUpper	3.29	358.7	01Jun2014, 14:54	128.9
HWC_Out	7.99	831.4	01Jun2014, 14:48	313.8
HWC1	0.81	96.7	01Jun2014, 14:15	32.1
HWC2	3.19	351.2	01Jun2014, 14:30	125.0
HWC3	3.29	358.9	01Jun2014, 14:33	128.9
SCBRANCH_R	6.11	690.1	01Jun2014, 14:51	265.6
SCNBranch	2.40	314.2	01Jun2014, 14:15	104.6
SCSBranch	3.71	394.9	01Jun2014, 14:57	160.9
SCSub1	0.42	85.1	01Jun2014, 13:09	16.6
SCSub2	0.41	103.9	01Jun2014, 12:54	15.7
SCSub3	0.31	68.8	01Jun2014, 13:03	12.3
SCSub4	0.34	95.8	01Jun2014, 13:03	17.9
SCSub5	0.14	37.6	01Jun2014, 12:51	5.4
SCS1_R	0.42	84.9	01Jun2014, 13:24	16.7
SCS2_R	0.41	103.3	01Jun2014, 13:18	15.7
SCS3_R	0.31	68.4	01Jun2014, 13:54	12.3
SCS4_R	0.34	95.0	01Jun2014, 14:09	17.9
SCS5_R	0.14	37.5	01Jun2014, 12:54	5.4
SC_Out	16.45	1760.4	01Jun2014, 15:12	712.7
SC1	1.96	171.0	01Jun2014, 15:39	85.6
SC2	3.81	470.2	01Jun2014, 14:24	165.2
SC2_R	12.87	1492.8	01Jun2014, 15:21	559.1
SC3	2.95	368.4	01Jun2014, 14:24	128.3
SC3_R	9.06	1045.2	01Jun2014, 14:54	393.9
TONGUE_RIVER	21.38	2172.7	01Jun2014, 14:54	948.3
TRD1	0.03	10.3	01Jun2014, 12:39	1.0
TRD2	0.51	74.0	01Jun2014, 13:33	18.9
TRD3	0.59	74.5	01Jun2014, 13:42	19.8
TRD4	0.27	80.4	01Jun2014, 12:57	13.7
TRD5	0.93	192.9	01Jun2014, 13:24	47.0
TR_Sub1	0.52	114.4	01Jun2014, 13:00	19.3
TR_Sub2	0.24	32.4	01Jun2014, 13:36	8.3

25-year, 24-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	486.2	01Jun2014, 21:57	181.8
GC1	0.34	131.0	01Jun2014, 20:51	28.1
GOOSE_CREEK	0.34	131.0	01Jun2014, 20:51	28.1
HWCLower	6.48	1160.7	01Jun2014, 22:30	462.3
HWCSub1	0.19	103.7	01Jun2014, 20:21	13.6
HWCSub2	0.14	92.2	01Jun2014, 20:15	10.3
HWCSub3	0.07	39.4	01Jun2014, 20:18	5.0
HWCSub4	0.18	80.4	01Jun2014, 20:27	12.5
HWCSub5	0.12	80.2	01Jun2014, 20:12	8.6
HWCS1_R	0.19	103.4	01Jun2014, 20:42	13.6
HWCS2_R	0.14	91.9	01Jun2014, 20:30	10.3
HWCS3_R	0.07	39.1	01Jun2014, 20:45	5.0
HWCS4_R	0.18	80.2	01Jun2014, 20:51	12.5
HWCS5_R	0.12	79.2	01Jun2014, 20:42	8.6
HWCUpper	3.29	591.6	01Jun2014, 22:27	234.7
HWC_Out	7.99	1351.7	01Jun2014, 22:24	570.0
HWC1	0.81	161.8	01Jun2014, 21:51	57.8
HWC2	3.19	580.7	01Jun2014, 22:06	227.6
HWC3	3.29	591.9	01Jun2014, 22:09	234.7
SCBRANCH_R	6.11	1104.8	01Jun2014, 22:27	475.5
SCNBranch	2.40	529.2	01Jun2014, 21:48	186.8
SCSBranch	3.71	629.9	01Jun2014, 22:39	288.7
SCSub1	0.42	159.1	01Jun2014, 20:39	30.0
SCSub2	0.41	198.8	01Jun2014, 20:24	28.4
SCSub3	0.31	129.9	01Jun2014, 20:33	22.1
SCSub4	0.34	180.9	01Jun2014, 20:33	30.7
SCSub5	0.14	72.1	01Jun2014, 20:21	9.7
SCS1_R	0.42	158.8	01Jun2014, 20:51	30.0
SCS2_R	0.41	197.2	01Jun2014, 20:42	28.4
SCS3_R	0.31	129.0	01Jun2014, 21:15	22.1
SCS4_R	0.34	179.3	01Jun2014, 21:27	30.7
SCS5_R	0.14	71.9	01Jun2014, 20:24	9.7
SC_Out	16.45	2811.7	01Jun2014, 22:48	1275.1
SC1	1.96	258.2	01Jun2014, 23:45	152.5
SC2	3.81	782.8	01Jun2014, 22:00	296.5
SC2_R	12.87	2431.3	01Jun2014, 22:51	1001.6
SC3	2.95	612.6	01Jun2014, 21:57	229.6
SC3_R	9.06	1689.5	01Jun2014, 22:27	705.1
TONGUE_RIVER	21.38	3494.3	01Jun2014, 22:36	1684.9
TRD1	0.03	20.7	01Jun2014, 20:09	1.9
TRD2	0.51	133.3	01Jun2014, 21:06	34.3
TRD3	0.59	132.9	01Jun2014, 21:12	36.4
TRD4	0.27	152.4	01Jun2014, 20:27	23.6
TRD5	0.93	352.9	01Jun2014, 20:57	81.4
TR_Sub1	0.52	217.2	01Jun2014, 20:30	35.0
TR_Sub2	0.24	58.1	01Jun2014, 21:09	15.3

50-year, 6-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	351.3	01Jun2014, 14:21	128.6
GC1	0.34	85.4	01Jun2014, 13:18	19.4
GOOSE_CREEK	0.34	85.4	01Jun2014, 13:18	19.4
HWCLower	6.48	856.1	01Jun2014, 14:57	310.5
HWCSub1	0.19	65.5	01Jun2014, 12:48	9.2
HWCSub2	0.14	57.0	01Jun2014, 12:42	7.0
HWCSub3	0.07	24.8	01Jun2014, 12:48	3.4
HWCSub4	0.18	51.6	01Jun2014, 12:57	8.5
HWCSub5	0.12	49.5	01Jun2014, 12:42	5.8
HWCS1_R	0.19	65.2	01Jun2014, 13:15	9.2
HWCS2_R	0.14	57.0	01Jun2014, 13:03	7.0
HWCS3_R	0.07	24.7	01Jun2014, 13:18	3.4
HWCS4_R	0.18	51.3	01Jun2014, 13:24	8.5
HWCS5_R	0.12	48.8	01Jun2014, 13:15	5.8
HWCUpper	3.29	436.1	01Jun2014, 14:51	157.6
HWC_Out	7.99	1011.2	01Jun2014, 14:45	383.6
HWC1	0.81	117.5	01Jun2014, 14:15	39.2
HWC2	3.19	426.9	01Jun2014, 14:30	152.9
HWC3	3.29	436.2	01Jun2014, 14:33	157.6
SCBRANCH_R	6.11	834.8	01Jun2014, 14:48	322.9
SCNBranch	2.40	379.5	01Jun2014, 14:15	127.2
SCSBranch	3.71	477.7	01Jun2014, 14:57	195.7
SCSub1	0.42	103.3	01Jun2014, 13:09	20.3
SCSub2	0.41	126.3	01Jun2014, 12:54	19.2
SCSub3	0.31	83.5	01Jun2014, 13:03	15.0
SCSub4	0.34	114.2	01Jun2014, 13:03	21.5
SCSub5	0.14	45.7	01Jun2014, 12:51	6.6
SCS1_R	0.42	103.1	01Jun2014, 13:21	20.4
SCS2_R	0.41	125.7	01Jun2014, 13:15	19.3
SCS3_R	0.31	83.1	01Jun2014, 13:51	15.1
SCS4_R	0.34	113.1	01Jun2014, 14:03	21.5
SCS5_R	0.14	45.6	01Jun2014, 12:54	6.6
SC_Out	16.45	2130.4	01Jun2014, 15:09	866.9
SC1	1.96	207.3	01Jun2014, 15:39	104.1
SC2	3.81	568.3	01Jun2014, 14:24	200.9
SC2_R	12.87	1808.4	01Jun2014, 15:18	680.0
SC3	2.95	445.1	01Jun2014, 14:24	156.1
SC3_R	9.06	1264.9	01Jun2014, 14:54	479.0
TONGUE_RIVER	21.38	2638.8	01Jun2014, 14:51	1151.3
TRD1	0.03	12.6	01Jun2014, 12:39	1.3
TRD2	0.51	90.2	01Jun2014, 13:33	23.2
TRD3	0.59	91.2	01Jun2014, 13:42	24.4
TRD4	0.27	96.0	01Jun2014, 12:57	16.5
TRD5	0.93	230.7	01Jun2014, 13:24	56.7
TR_Sub1	0.52	139.3	01Jun2014, 13:00	23.6
TR_Sub2	0.24	39.6	01Jun2014, 13:36	10.2

50-year, 24-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	573.7	01Jun2014, 21:57	214.1
GC1	0.34	156.9	01Jun2014, 20:51	33.5
GOOSE_CREEK	0.34	156.9	01Jun2014, 20:51	33.5
HWCLower	6.48	1404.7	01Jun2014, 22:27	556.6
HWCSub1	0.19	125.4	01Jun2014, 20:21	16.3
HWCSub2	0.14	111.2	01Jun2014, 20:15	12.4
HWCSub3	0.07	47.6	01Jun2014, 20:18	6.0
HWCSub4	0.18	97.5	01Jun2014, 20:27	15.0
HWCSub5	0.12	97.0	01Jun2014, 20:12	10.3
HWCS1_R	0.19	124.9	01Jun2014, 20:39	16.3
HWCS2_R	0.14	110.7	01Jun2014, 20:30	12.4
HWCS3_R	0.07	47.4	01Jun2014, 20:42	6.0
HWCS4_R	0.18	97.1	01Jun2014, 20:48	15.1
HWCS5_R	0.12	96.0	01Jun2014, 20:39	10.3
HWCUpper	3.29	715.4	01Jun2014, 22:24	282.6
HWC_Out	7.99	1635.6	01Jun2014, 22:21	686.3
HWC1	0.81	195.7	01Jun2014, 21:48	69.6
HWC2	3.19	702.0	01Jun2014, 22:06	274.0
HWC3	3.29	715.6	01Jun2014, 22:06	282.6
SCBRANCH_R	6.11	1328.4	01Jun2014, 22:24	569.6
SCNBranch	2.40	636.3	01Jun2014, 21:48	223.7
SCSBranch	3.71	757.1	01Jun2014, 22:39	345.9
SCSub1	0.42	192.4	01Jun2014, 20:39	36.1
SCSub2	0.41	240.9	01Jun2014, 20:24	34.3
SCSub3	0.31	157.2	01Jun2014, 20:33	26.6
SCSub4	0.34	215.1	01Jun2014, 20:33	36.4
SCSub5	0.14	87.4	01Jun2014, 20:21	11.7
SCS1_R	0.42	192.1	01Jun2014, 20:51	36.1
SCS2_R	0.41	239.4	01Jun2014, 20:42	34.3
SCS3_R	0.31	156.0	01Jun2014, 21:12	26.6
SCS4_R	0.34	213.3	01Jun2014, 21:24	36.4
SCS5_R	0.14	87.1	01Jun2014, 20:24	11.7
SC_Out	16.45	3379.9	01Jun2014, 22:45	1527.6
SC1	1.96	310.3	01Jun2014, 23:45	182.7
SC2	3.81	941.1	01Jun2014, 22:00	355.2
SC2_R	12.87	2928.6	01Jun2014, 22:48	1199.8
SC3	2.95	736.6	01Jun2014, 21:57	275.0
SC3_R	9.06	2033.1	01Jun2014, 22:27	844.6
TONGUE_RIVER	21.38	4204.2	01Jun2014, 22:33	2015.4
TRD1	0.03	25.1	01Jun2014, 20:09	2.3
TRD2	0.51	161.8	01Jun2014, 21:06	41.5
TRD3	0.59	162.0	01Jun2014, 21:12	44.2
TRD4	0.27	181.7	01Jun2014, 20:27	28.1
TRD5	0.93	420.7	01Jun2014, 20:57	96.8
TR_Sub1	0.52	263.7	01Jun2014, 20:30	42.3
TR_Sub2	0.24	70.7	01Jun2014, 21:09	18.5

100-year, 6-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	407.1	01Jun2014, 14:21	150.1
GC1	0.34	100.1	01Jun2014, 13:18	22.9
GOOSE_CREEK	0.34	100.1	01Jun2014, 13:18	22.9
HWCLower	6.48	1015.5	01Jun2014, 14:54	370.0
HWCSub1	0.19	77.5	01Jun2014, 12:48	11.0
HWCSub2	0.14	67.4	01Jun2014, 12:42	8.3
HWCSub3	0.07	29.3	01Jun2014, 12:48	4.0
HWCSub4	0.18	61.1	01Jun2014, 12:57	10.1
HWCSub5	0.12	58.6	01Jun2014, 12:42	6.9
HWCS1_R	0.19	77.1	01Jun2014, 13:12	11.0
HWCS2_R	0.14	67.0	01Jun2014, 13:03	8.4
HWCS3_R	0.07	29.1	01Jun2014, 13:15	4.1
HWCS4_R	0.18	60.9	01Jun2014, 13:21	10.1
HWCS5_R	0.12	58.0	01Jun2014, 13:15	7.0
HWCUpper	3.29	516.9	01Jun2014, 14:51	187.8
HWC_Out	7.99	1199.1	01Jun2014, 14:45	457.2
HWC1	0.81	139.2	01Jun2014, 14:15	46.7
HWC2	3.19	506.0	01Jun2014, 14:30	182.1
HWC3	3.29	517.1	01Jun2014, 14:30	187.8
SCBRANCH_R	6.11	985.1	01Jun2014, 14:48	383.0
SCNBranch	2.40	447.3	01Jun2014, 14:15	150.9
SCSBranch	3.71	563.8	01Jun2014, 14:54	232.1
SCSub1	0.42	122.2	01Jun2014, 13:09	24.2
SCSub2	0.41	149.6	01Jun2014, 12:54	23.0
SCSub3	0.31	98.8	01Jun2014, 13:03	17.9
SCSub4	0.34	132.9	01Jun2014, 13:03	25.3
SCSub5	0.14	54.1	01Jun2014, 12:51	7.8
SCS1_R	0.42	122.0	01Jun2014, 13:21	24.3
SCS2_R	0.41	148.8	01Jun2014, 13:15	23.0
SCS3_R	0.31	98.3	01Jun2014, 13:48	17.9
SCS4_R	0.34	131.8	01Jun2014, 14:00	25.3
SCS5_R	0.14	54.0	01Jun2014, 12:54	7.8
SC_Out	16.45	2514.9	01Jun2014, 15:06	1028.3
SC1	1.96	245.1	01Jun2014, 15:39	123.4
SC2	3.81	670.1	01Jun2014, 14:24	238.3
SC2_R	12.87	2136.4	01Jun2014, 15:15	806.5
SC3	2.95	524.7	01Jun2014, 14:24	185.1
SC3_R	9.06	1493.6	01Jun2014, 14:51	568.1
TONGUE_RIVER	21.38	3124.1	01Jun2014, 14:48	1363.4
TRD1	0.03	15.0	01Jun2014, 12:39	1.5
TRD2	0.51	107.1	01Jun2014, 13:33	27.7
TRD3	0.59	108.8	01Jun2014, 13:42	29.2
TRD4	0.27	112.1	01Jun2014, 12:57	19.4
TRD5	0.93	269.4	01Jun2014, 13:24	66.7
TR_Sub1	0.52	165.4	01Jun2014, 13:00	28.2
TR_Sub2	0.24	47.2	01Jun2014, 13:36	12.3

100-year, 24-hour Type II Storm Event

Hydrologic Element	Drainage Area (mi^2)	Peak Discharge (cfs)	Time of Peak	Volume (Ac-ft)
EF EC	1.84	662.6	01Jun2014, 21:57	247.0
GC1	0.34	183.5	01Jun2014, 20:51	39.1
GOOSE_CREEK	0.34	183.5	01Jun2014, 20:51	39.1
HWCLower	6.48	1658.7	01Jun2014, 22:27	654.7
HWCSub1	0.19	148.0	01Jun2014, 20:21	19.2
HWCSub2	0.14	131.0	01Jun2014, 20:15	14.5
HWCSub3	0.07	56.2	01Jun2014, 20:18	7.1
HWCSub4	0.18	115.3	01Jun2014, 20:27	17.7
HWCSub5	0.12	114.5	01Jun2014, 20:12	12.1
HWCS1_R	0.19	147.7	01Jun2014, 20:39	19.2
HWCS2_R	0.14	130.1	01Jun2014, 20:27	14.5
HWCS3_R	0.07	55.8	01Jun2014, 20:42	7.1
HWCS4_R	0.18	115.0	01Jun2014, 20:48	17.7
HWCS5_R	0.12	113.0	01Jun2014, 20:39	12.1
HWCUpper	3.29	844.2	01Jun2014, 22:24	332.4
HWC_Out	7.99	1931.1	01Jun2014, 22:21	807.2
HWC1	0.81	231.0	01Jun2014, 21:48	81.8
HWC2	3.19	828.4	01Jun2014, 22:06	322.3
HWC3	3.29	844.6	01Jun2014, 22:06	332.4
SCBRANCH_R	6.11	1560.1	01Jun2014, 22:24	666.8
SCNBranch	2.40	747.2	01Jun2014, 21:48	261.9
SCSBranch	3.71	888.9	01Jun2014, 22:36	404.9
SCSub1	0.42	227.2	01Jun2014, 20:39	42.4
SCSub2	0.41	284.9	01Jun2014, 20:24	40.4
SCSub3	0.31	185.6	01Jun2014, 20:33	31.3
SCSub4	0.34	250.2	01Jun2014, 20:33	42.2
SCSub5	0.14	103.3	01Jun2014, 20:21	13.8
SCS1_R	0.42	226.7	01Jun2014, 20:51	42.4
SCS2_R	0.41	282.7	01Jun2014, 20:42	40.4
SCS3_R	0.31	184.0	01Jun2014, 21:12	31.3
SCS4_R	0.34	248.1	01Jun2014, 21:21	42.2
SCS5_R	0.14	103.0	01Jun2014, 20:24	13.8
SC_Out	16.45	3968.2	01Jun2014, 22:42	1788.6
SC1	1.96	364.2	01Jun2014, 23:45	213.9
SC2	3.81	1105.1	01Jun2014, 22:00	415.8
SC2_R	12.87	3444.4	01Jun2014, 22:45	1404.5
SC3	2.95	865.0	01Jun2014, 21:57	322.0
SC3_R	9.06	2389.7	01Jun2014, 22:24	988.8
TONGUE_RIVER	21.38	4938.8	01Jun2014, 22:30	2356.6
TRD1	0.03	29.8	01Jun2014, 20:09	2.7
TRD2	0.51	191.6	01Jun2014, 21:06	48.9
TRD3	0.59	192.7	01Jun2014, 21:12	52.4
TRD4	0.27	211.8	01Jun2014, 20:27	32.7
TRD5	0.93	490.2	01Jun2014, 20:57	112.5
TR_Sub1	0.52	312.3	01Jun2014, 20:30	49.9
TR_Sub2	0.24	84.0	01Jun2014, 21:09	21.9

ADDENDUM RP-2

Miller Regression Analysis

Peak Flow Estimates using Methods Presented by Miller, 2003

Drainage: **Hidden Water Creek**

Input Parameters:

Drainage Area (square miles) =	**7.99**
Region (See WRI Report 03-4107 Plate 1) =	**2**

Output Parameters:

2-Year Annual Peak Flow **80 cfs**

$$Q_2 = 29.9(AREA^{0.475})$$

5-Year Annual Peak Flow **208 cfs**

$$Q_5 = 80.9(AREA^{0.455})$$

10-Year Annual Peak Flow **339 cfs**

$$Q_{10} = 134(AREA^{0.447})$$

25-Year Annual Peak Flow **560 cfs**

$$Q_{25} = 225(AREA^{0.439})$$

50-Year Annual Peak Flow **766 cfs**

$$Q_{50} = 311(AREA^{0.434})$$

100-Year Annual Peak Flow **1,014 cfs**

$$Q_{100} = 415(AREA^{0.430})$$

Peak Flow Estimates using Methods Presented by Miller, 2003

Drainage: **Slater Creek**

Input Parameters:

Drainage Area (square miles) = **16.44**
Region (See WRI Report 03-4107 Plate 1) = **2**

Output Parameters:

2-Year Annual Peak Flow **113 cfs**

$$Q_2 = 29.9(AREA^{0.475})$$

5-Year Annual Peak Flow **289 cfs**

$$Q_5 = 80.9(AREA^{0.455})$$

10-Year Annual Peak Flow **468 cfs**

$$Q_{10} = 134(AREA^{0.447})$$

25-Year Annual Peak Flow **769 cfs**

$$Q_{25} = 225(AREA^{0.439})$$

50-Year Annual Peak Flow **1,048 cfs**

$$Q_{50} = 311(AREA^{0.434})$$

100-Year Annual Peak Flow **1,383 cfs**

$$Q_{100} = 415(AREA^{0.430})$$

ADDENDUM RP-3

HEC-RAS RESULTS

HEC-RAS RESULTS

HEC-RAS Results: Hidden Water Creek Postmine

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Mann Wtd Total	Hydr Radius
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)			(ft)
1	16164.28	2-YEAR	474.9	3854.3	3856.2	3856.2	3856.7	0.0119	5.69	83.48	85.78	1.02	0.028	0.97
1	16164.28	100-YEAR	1931.1	3854.3	3857.7	3857.7	3858.7	0.0080	8.23	243.48	125.39	0.96	0.026	1.94
1	16000	2-YEAR	474.9	3852.0	3853.1	3853.1	3853.5	0.0121	5.34	88.93	101.42	1.01	0.028	0.88
1	16000	100-YEAR	1931.1	3852.0	3854.4	3854.4	3855.3	0.0092	7.75	250.55	142.5	1	0.027	1.76
1	15500	2-YEAR	474.9	3845.1	3846.8	3846.7	3847.2	0.0092	5.03	94.44	96.03	0.89	0.028	0.98
1	15500	100-YEAR	1931.1	3845.1	3848.1	3848.1	3849.0	0.0094	7.55	256.08	149.52	1	0.027	1.71
1	15000	2-YEAR	474.9	3840.0	3841.4	3841.4	3841.8	0.0127	5.02	94.51	122.52	1.01	0.028	0.77
1	15000	100-YEAR	1931.1	3840.0	3842.6	3842.6	3843.4	0.0096	7.15	273.38	183.38	0.99	0.027	1.49
1	14500	2-YEAR	474.9	3831.8	3833.1	3833.1	3833.5	0.0121	5.35	88.75	101.1	1.01	0.028	0.88
1	14500	100-YEAR	1931.1	3831.8	3834.4	3834.4	3835.3	0.0094	7.46	261.11	162.27	0.99	0.027	1.61
1	14000	2-YEAR	474.9	3821.5	3823.6	3823.6	3824.1	0.0113	6.07	78.28	69.95	1.01	0.028	1.12
1	14000	100-YEAR	1931.1	3821.5	3825.3	3825.3	3826.4	0.0073	8.71	236.04	113.33	0.94	0.025	2.08
1	13500	2-YEAR	474.9	3813.9	3815.5	3815.4	3816.0	0.0086	5.41	87.8	76.26	0.89	0.028	1.15
1	13500	100-YEAR	1931.1	3813.9	3817.1	3817.1	3818.2	0.0077	8.59	233.38	112.24	0.96	0.026	2.07
1	13000	2-YEAR	474.9	3808.4	3810.5	3810.5	3811.1	0.0114	5.99	79.22	72.63	1.01	0.028	1.09
1	13000	100-YEAR	1931.1	3808.4	3812.2	3812.2	3813.2	0.0090	8.07	240.02	128.39	1	0.027	1.86
1	12500	2-YEAR	474.9	3801.5	3803.4	3803.4	3803.9	0.0118	5.64	84.2	86.82	1.01	0.028	0.97
1	12500	100-YEAR	1931.1	3801.5	3804.9	3804.9	3805.7	0.0075	7.64	269.34	170.78	0.92	0.024	1.57
1	12000	2-YEAR	474.9	3793.1	3794.5	3794.5	3794.9	0.0101	5.26	96.88	129.38	0.94	0.025	0.75
1	12000	100-YEAR	1931.1	3793.1	3795.8	3795.8	3796.5	0.0070	7.54	316.65	227.28	0.89	0.025	1.39
1	11500	2-YEAR	474.9	3782.9	3784.9	3784.9	3785.5	0.0113	5.99	79.23	72.26	1.01	0.028	1.09
1	11500	100-YEAR	1931.1	3782.9	3786.6	3786.6	3787.6	0.0082	8.24	239.79	128.85	0.97	0.025	1.86

HEC-RAS Results: Hidden Water Creek Postmine

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Mann Wtd Total	Hydr Radius
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)			(ft)
1	11000	2-YEAR	474.9	3776.0	3778.0	3778.0	3778.6	0.0113	6.07	78.18	69.65	1.01	0.028	1.12
1	11000	100-YEAR	1931.1	3776.0	3779.7	3779.7	3780.7	0.0092	8.15	236.88	116.49	1.01	0.028	2.02
1	10500	2-YEAR	474.9	3767.9	3769.2	3769.2	3769.7	0.0117	5.62	84.55	87.41	1.01	0.028	0.97
1	10500	100-YEAR	1931.1	3767.9	3770.7	3770.7	3771.7	0.0083	8.16	243.56	128.23	0.97	0.026	1.9
1	10000	2-YEAR	474.9	3759.2	3761.6	3761.6	3762.2	0.0114	6.04	78.56	71.23	1.01	0.028	1.1
1	10000	100-YEAR	1931.1	3759.2	3763.3	3763.3	3764.4	0.0074	8.54	240.52	119.89	0.94	0.025	2
1	9500	2-YEAR	474.9	3751.5	3753.7	3753.7	3754.3	0.0107	6.53	72.77	55.87	1.01	0.028	1.3
1	9500	100-YEAR	1931.1	3751.5	3755.7	3755.7	3757.0	0.0068	9.37	221.86	93	0.93	0.025	2.37
1	9000	2-YEAR	474.9	3744.0	3746.2	3746.2	3746.8	0.0111	6.24	76.05	64.38	1.01	0.028	1.18
1	9000	100-YEAR	1931.1	3744.0	3748.1	3748.1	3749.3	0.0084	8.93	216.61	89.07	1	0.028	2.42
1	8500	2-YEAR	474.9	3736.9	3739.0	3739.0	3739.6	0.0088	6.69	78.02	64.67	0.95	0.026	1.2
1	8500	100-YEAR	1931.1	3736.9	3740.9	3740.9	3742.1	0.0066	9.87	236.59	98.9	0.93	0.026	2.38
1	8000	2-YEAR	474.9	3730.7	3732.4	3732.4	3732.9	0.0116	5.66	83.94	85.73	1	0.028	0.98
1	8000	100-YEAR	1931.1	3730.7	3734.0	3734.0	3735.0	0.0075	8.33	247.75	128.45	0.94	0.025	1.93
1	7500	2-YEAR	474.9	3722.3	3724.2	3724.2	3724.7	0.0119	5.74	82.82	85.77	1.02	0.028	0.96
1	7500	100-YEAR	1931.1	3722.3	3725.7	3725.7	3726.8	0.0074	8.53	242.33	117.94	0.94	0.026	2.05
1	7000	2-YEAR	474.9	3714.7	3716.6	3716.6	3717.1	0.0089	5.91	88.37	95.51	0.92	0.025	0.92
1	7000	100-YEAR	1931.1	3714.7	3718.1	3718.1	3719.0	0.0065	8.47	293.02	177	0.89	0.025	1.65
1	6500	2-YEAR	474.9	3707.9	3709.4	3709.4	3710.0	0.0115	5.84	81.3	77.84	1.01	0.028	1.04
1	6500	100-YEAR	1931.1	3707.9	3711.0	3711.0	3712.1	0.0082	8.49	233.02	112.43	0.98	0.026	2.07
1	6000	2-YEAR	474.9	3700.7	3702.3	3702.3	3702.8	0.0114	5.57	86.12	95.56	0.99	0.027	0.9
1	6000	100-YEAR	1931.1	3700.7	3703.8	3703.8	3704.8	0.0074	8.28	256.68	137.93	0.94	0.026	1.86

Scanned, 03/02/2020

October 2014

RAMACO

HEC-RAS Results: Hidden Water Creek Postmine

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Mann Wtd Total	Hydr Radius
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)			(ft)
1	5500	2-YEAR	474.9	3692.0	3693.4	3693.4	3693.9	0.0096	5.48	86.65	79.98	0.93	0.028	1.08
1	5500	100-YEAR	1931.1	3692.0	3694.9	3694.9	3696.0	0.0081	8.46	234.58	114.8	0.97	0.026	2.04
1	5000	2-YEAR	474.9	3686.3	3688.1	3688.1	3688.5	0.0121	5.57	85.37	92.78	1.02	0.028	0.92
1	5000	100-YEAR	1931.1	3686.3	3689.5	3689.5	3690.6	0.0077	8.36	245.62	125.21	0.95	0.026	1.96
1	4500	2-YEAR	474.9	3679.7	3681.2	3681.0	3681.5	0.0078	4.7	100.94	100.42	0.83	0.028	1
1	4500	100-YEAR	1931.1	3679.7	3682.4	3682.4	3683.3	0.0092	7.81	248.58	139.13	1	0.027	1.78
1	4000	2-YEAR	474.9	3674.3	3676.5	3676.5	3677.1	0.0100	6.28	77.51	69.84	0.97	0.026	1.11
1	4000	100-YEAR	1931.1	3674.3	3678.3	3678.3	3679.4	0.0065	9.11	248.25	119.21	0.91	0.025	2.08
1	3500	2-YEAR	474.9	3669.4	3671.2	3671.1	3671.6	0.0081	5.08	93.49	85.49	0.85	0.028	1.09
1	3500	100-YEAR	1931.1	3669.4	3672.6	3672.6	3673.7	0.0074	8.31	249.2	132.76	0.93	0.025	1.87
1	3000	2-YEAR	474.9	3665.3	3666.6	3666.6	3666.9	0.0108	5.12	97.52	130.17	0.96	0.026	0.75
1	3000	100-YEAR	1931.1	3665.3	3667.8	3667.8	3668.5	0.0074	7.52	298.04	197.31	0.91	0.026	1.51
1	2500	2-YEAR	474.9	3653.6	3661.8		3661.8	0.0000	0.63	936.03	201.02	0.04	0.026	4.64
1	2500	100-YEAR	1931.1	3653.6	3664.1		3664.1	0.0001	1.75	1511.9	308.88	0.1	0.025	4.88
1	2000	2-YEAR	474.9	3656.0	3661.8		3661.8	0.0000	0.36	1474.68	345.56	0.03	0.029	4.19
1	2000	100-YEAR	1931.1	3656.0	3664.1		3664.1	0.0000	0.95	2280.27	361.2	0.06	0.029	6.16
1	1500	2-YEAR	474.9	3658.0	3661.0	3661.0	3661.7	0.0099	6.76	70.23	48.17	0.99	0.028	1.45
1	1500	100-YEAR	1931.1	3658.0	3663.1	3663.1	3664.0	0.0055	8.17	284.59	153.78	0.83	0.024	1.84
1	1000	2-YEAR	474.9	3636.6	3639.5	3639.5	3640.3	0.0104	6.97	68.17	46.39	1.01	0.028	1.46
1	1000	100-YEAR	1931.1	3636.6	3641.7	3641.7	3643.2	0.0084	9.77	197.72	68.31	1.01	0.028	2.86
1	500	2-YEAR	474.9	3624.0	3626.5	3626.5	3627.3	0.0102	6.99	67.96	45.23	1	0.028	1.49
1	500	100-YEAR	1931.1	3624.0	3628.7	3628.7	3630.2	0.0084	9.64	200.25	70.85	1.01	0.028	2.79

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Addendum RP-3-5

Brook Mine

HEC-RAS Results: Hidden Water Creek Postmine

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Mann Wtd Total	Hydr Radius
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)			(ft)
1	250	2-YEAR	474.9	3608.9	3610.3	3610.3	3610.7	0.0116	5.25	92.43	115.42	0.98	0.027	0.8
1	250	100-YEAR	1931.1	3608.9	3613.0	3611.6	3613.2	0.0012	4.25	523.81	202.09	0.4	0.026	2.59

HEC-RAS Results: Slater Creek Postmine

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Mann Wtd Total	Hydr Radius
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)			(ft)
1	13500	2-YEAR	1021.6	3806.0	3807.6	3807.5	3808.2	0.0087	5.97	171.25	129.48	0.91	0.028	1.32
1	13500	100-YEAR	3968.2	3806.0	3809.4	3809.4	3810.1	0.0059	7.41	664.12	479.95	0.83	0.024	1.38
1	13000	2-YEAR	1021.6	3800.5	3802.7	3802.7	3803.3	0.0112	5.88	173.93	167.68	1	0.027	1.04
1	13000	100-YEAR	3968.2	3800.5	3804.5	3804.5	3805.2	0.0051	7.28	675.14	489.44	0.79	0.022	1.38
1	12500	2-YEAR	1021.6	3796.0	3797.1	3797.1	3797.4	0.0122	4.86	212.57	303.37	0.99	0.027	0.7
1	12500	100-YEAR	3968.2	3796.0	3798.1	3798.1	3798.9	0.0086	7.09	599.75	422.22	0.95	0.026	1.42
1	12000	2-YEAR	1021.6	3789.5	3791.3	3791.3	3791.8	0.0092	5.9	197.39	215.1	0.93	0.026	0.92
1	12000	100-YEAR	3968.2	3789.5	3792.7	3792.7	3793.5	0.0073	8.23	619.57	418.82	0.93	0.026	1.48
1	11500	2-YEAR	1021.6	3784.7	3786.4	3786.4	3786.6	0.0074	4.61	306.74	576.28	0.81	0.025	0.53
1	11500	100-YEAR	3968.2	3784.7	3787.1	3787.1	3787.6	0.0093	7.04	727.22	649.99	0.97	0.028	1.12
1	11000	2-YEAR	1021.6	3778.0	3779.3	3779.3	3779.8	0.0115	5.79	176.54	171.74	1.01	0.028	1.03
1	11000	100-YEAR	3968.2	3778.0	3780.9	3780.9	3781.8	0.0072	7.89	538.85	331.43	0.91	0.024	1.63
1	10500	2-YEAR	1021.6	3771.5	3774.6	3774.6	3775.1	0.0075	5.71	208.51	225.6	0.85	0.025	0.92
1	10500	100-YEAR	3968.2	3771.5	3775.9	3775.9	3776.6	0.0091	7.54	601.9	403.45	0.98	0.028	1.49
1	10000	2-YEAR	1021.6	3764.6	3766.9	3766.9	3767.4	0.0118	5.5	185.8	198.8	1	0.028	0.93
1	10000	100-YEAR	3968.2	3764.6	3768.2	3768.2	3769.0	0.0093	6.99	574.95	400.49	0.97	0.026	1.43
1	9500	2-YEAR	1021.6	3757.3	3759.1	3758.9	3759.5	0.0074	4.87	209.81	189.81	0.82	0.028	1.11
1	9500	100-YEAR	3968.2	3757.3	3760.6	3760.4	3761.4	0.0061	7.09	571.09	296.5	0.83	0.026	1.93
1	9000	2-YEAR	1021.6	3752.0	3754.4	3754.4	3755.1	0.0105	6.78	150.7	108.23	1.01	0.028	1.39
1	9000	100-YEAR	3968.2	3752.0	3756.4	3756.4	3757.8	0.0082	9.45	419.84	152.19	1	0.028	2.75
1	8500	2-YEAR	1021.6	3746.0	3747.9		3748.1	0.0024	3.44	296.74	192.33	0.49	0.028	1.54
1	8500	100-YEAR	3968.2	3746.0	3749.5		3750.1	0.0033	6.15	674.61	295.45	0.64	0.025	2.28

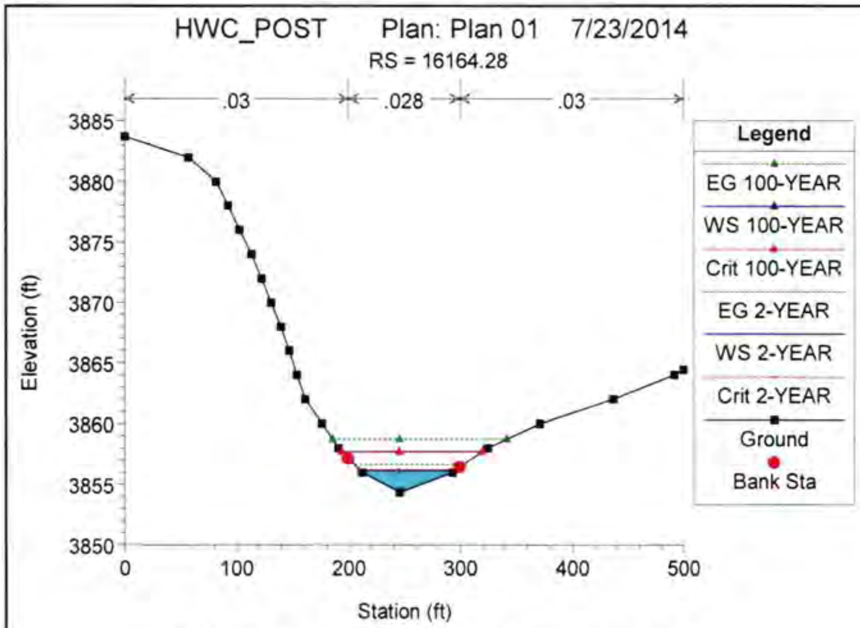
HEC-RAS Results: Slater Creek Postmine

Reach	River Sta	Profile	Q Total (cfs)	Min Ch El (ft)	W.S. Elev (ft)	Crit W.S. (ft)	E.G. Elev (ft)	E.G. Slope (ft/ft)	Vel Chnl (ft/s)	Flow Area (sq ft)	Top Width (ft)	Froude # Chl	Mann Wtd Total	Hydr Radius (ft)
1	8000	2-YEAR	1021.6	3744.0	3745.5	3745.5	3745.9	0.0104	5.3	196.42	231.16	0.95	0.026	0.85
1	8000	100-YEAR	3968.2	3744.0	3746.8	3746.8	3747.6	0.0076	7.79	564.07	330.58	0.93	0.026	1.71
1	7500	2-YEAR	1021.6	3738.6	3740.9	3740.9	3741.5	0.0077	6.45	181.89	171.36	0.89	0.024	1.06
1	7500	100-YEAR	3968.2	3738.6	3742.6	3742.6	3743.5	0.0060	9.01	570.09	283.72	0.88	0.026	2.01
1	7227.464	2-YEAR	1021.6	3737.0	3738.6	3738.6	3739.0	0.0094	5.57	209.38	255.49	0.93	0.026	0.82
1	7227.464	100-YEAR	3968.2	3737.0	3739.8	3739.8	3740.7	0.0077	8.25	587.63	362.96	0.95	0.027	1.62
1	7000	2-YEAR	1021.6	3733.3	3735.4	3735.4	3735.9	0.0108	5.29	193.1	205.1	0.96	0.028	0.94
1	7000	100-YEAR	3968.2	3733.3	3736.7	3736.7	3737.6	0.0089	7.67	525.13	303.66	0.98	0.027	1.73
1	6500	2-YEAR	1021.6	3728.4	3730.6	3730.6	3731.1	0.0085	5.88	198.02	209.93	0.9	0.026	0.94
1	6500	100-YEAR	3968.2	3728.4	3732.0	3732.0	3732.9	0.0079	8.53	548.79	299.02	0.96	0.027	1.83
1	6000	2-YEAR	1021.6	3720.1	3721.8	3721.8	3722.3	0.0124	5.32	192.26	230.22	1.01	0.028	0.84
1	6000	100-YEAR	3968.2	3720.1	3723.1	3723.1	3724.0	0.0083	7.74	542.48	323.16	0.96	0.026	1.68
1	5500	2-YEAR	1021.6	3713.1	3714.6	3714.5	3715.0	0.0089	4.78	213.77	228.56	0.87	0.028	0.94
1	5500	100-YEAR	3968.2	3713.1	3716.2		3716.8	0.0046	5.88	674.99	328.6	0.72	0.028	2.05
1	5000	2-YEAR	1021.6	3709.2	3711.2		3711.5	0.0055	4.81	212.38	157.06	0.73	0.028	1.35
1	5000	100-YEAR	3968.2	3709.2	3712.5	3712.5	3713.7	0.0081	8.85	456.2	197.76	0.98	0.027	2.3
1	4877.632	2-YEAR	1021.6	3708.4	3710.2	3710.2	3710.6	0.0088	5.98	201.61	213.2	0.92	0.027	0.95
1	4877.632	100-YEAR	3968.2	3708.4	3711.5	3711.5	3712.6	0.0081	9.13	506.15	244.31	0.99	0.028	2.07
1	4196.757	2-YEAR	1021.6	3698.4	3700.7		3701.1	0.0056	5.17	205.78	167.16	0.75	0.026	1.23
1	4196.757	100-YEAR	3968.2	3698.4	3702.6		3703.3	0.0039	7.47	610.76	247.42	0.72	0.026	2.46
1	4000	2-YEAR	1021.6	3696.4	3698.9	3698.9	3699.6	0.0105	6.71	152.26	111.24	1.01	0.028	1.37
1	4000	100-YEAR	3968.2	3696.4	3700.9	3700.9	3702.2	0.0075	9.43	430.09	166.46	0.97	0.026	2.58

HEC-RAS Results: Slater Creek Postmine

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl	Mann Wtd Total	Hydr Radius
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)			(ft)
1	3500	2-YEAR	1021.6	3689.7	3691.9	3691.9	3692.7	0.0101	6.95	147.07	99.08	1	0.028	1.48
1	3500	100-YEAR	3968.2	3689.7	3694.1	3694.1	3695.5	0.0084	9.43	420.79	157.58	1.01	0.028	2.66
1	3000	2-YEAR	1021.6	3682.9	3685.2	3684.9	3685.6	0.0056	5.33	191.64	122.48	0.75	0.028	1.56
1	3000	100-YEAR	3968.2	3682.9	3687.3		3688.3	0.0048	8.08	491.14	150.83	0.79	0.028	3.24
1	2500	2-YEAR	1021.6	3677.2	3681.1	3681.1	3682.0	0.0096	7.55	135.29	77.03	1	0.028	1.74
1	2500	100-YEAR	3968.2	3677.2	3683.6	3683.6	3685.2	0.0079	10.27	386.46	119.87	1.01	0.028	3.2
1	2000	2-YEAR	1021.6	3672.0	3675.1	3675.1	3676.0	0.0095	7.81	130.82	70.35	1.01	0.028	1.85
1	2000	100-YEAR	3968.2	3672.0	3677.8	3677.8	3679.5	0.0073	10.62	379.87	113.48	0.98	0.027	3.33
1	1275.216	2-YEAR	1021.6	3660.0	3663.2	3663.2	3664.2	0.0093	8.06	126.75	63.91	1.01	0.028	1.97
1	1275.216	100-YEAR	3968.2	3660.0	3666.1	3666.1	3667.9	0.0060	10.96	385.46	117.48	0.92	0.025	3.26
1	1000	2-YEAR	1021.6	3656.0	3657.7	3657.7	3658.2	0.0102	5.97	171.88	155.97	0.97	0.027	1.1
1	1000	100-YEAR	3968.2	3656.0	3659.3	3659.3	3660.5	0.0075	9.01	470.19	204.6	0.96	0.026	2.3
1	500	2-YEAR	1021.6	3650.7	3652.5	3652.5	3653.1	0.0104	6.01	171.87	156.2	0.98	0.027	1.1
1	500	100-YEAR	3968.2	3650.7	3654.2	3654.2	3655.4	0.0075	9.16	460.8	194.43	0.96	0.027	2.37

HEC-RAS SECTIONS



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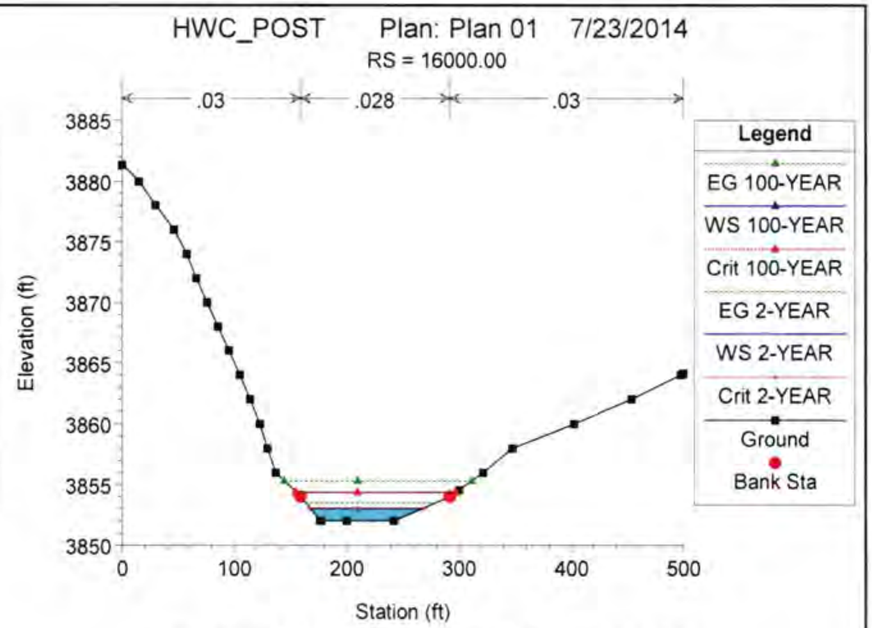
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)



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Legend
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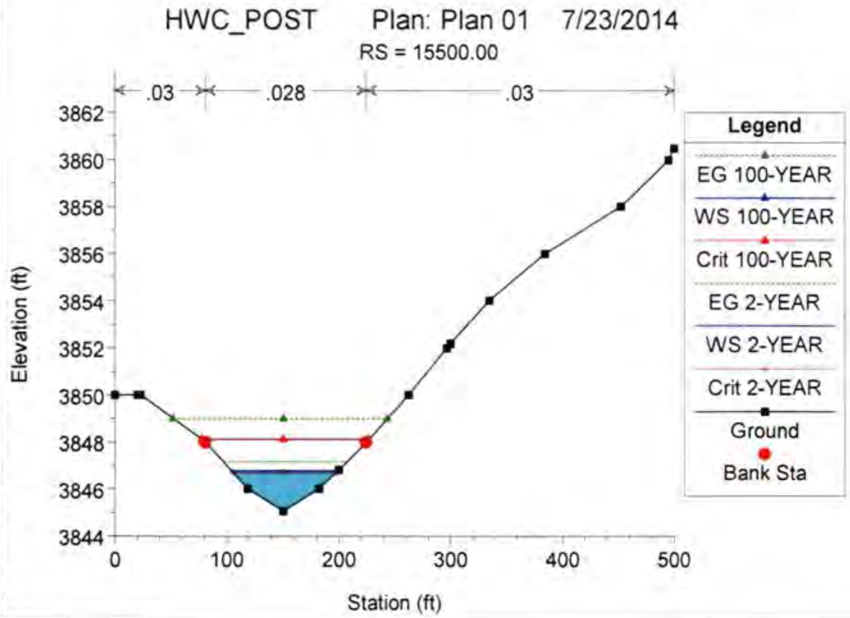
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)



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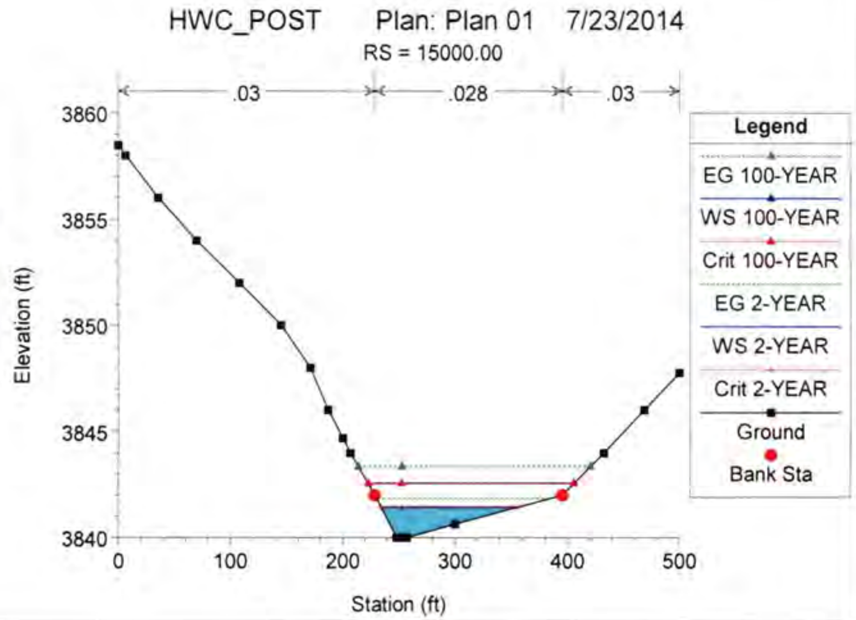
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)



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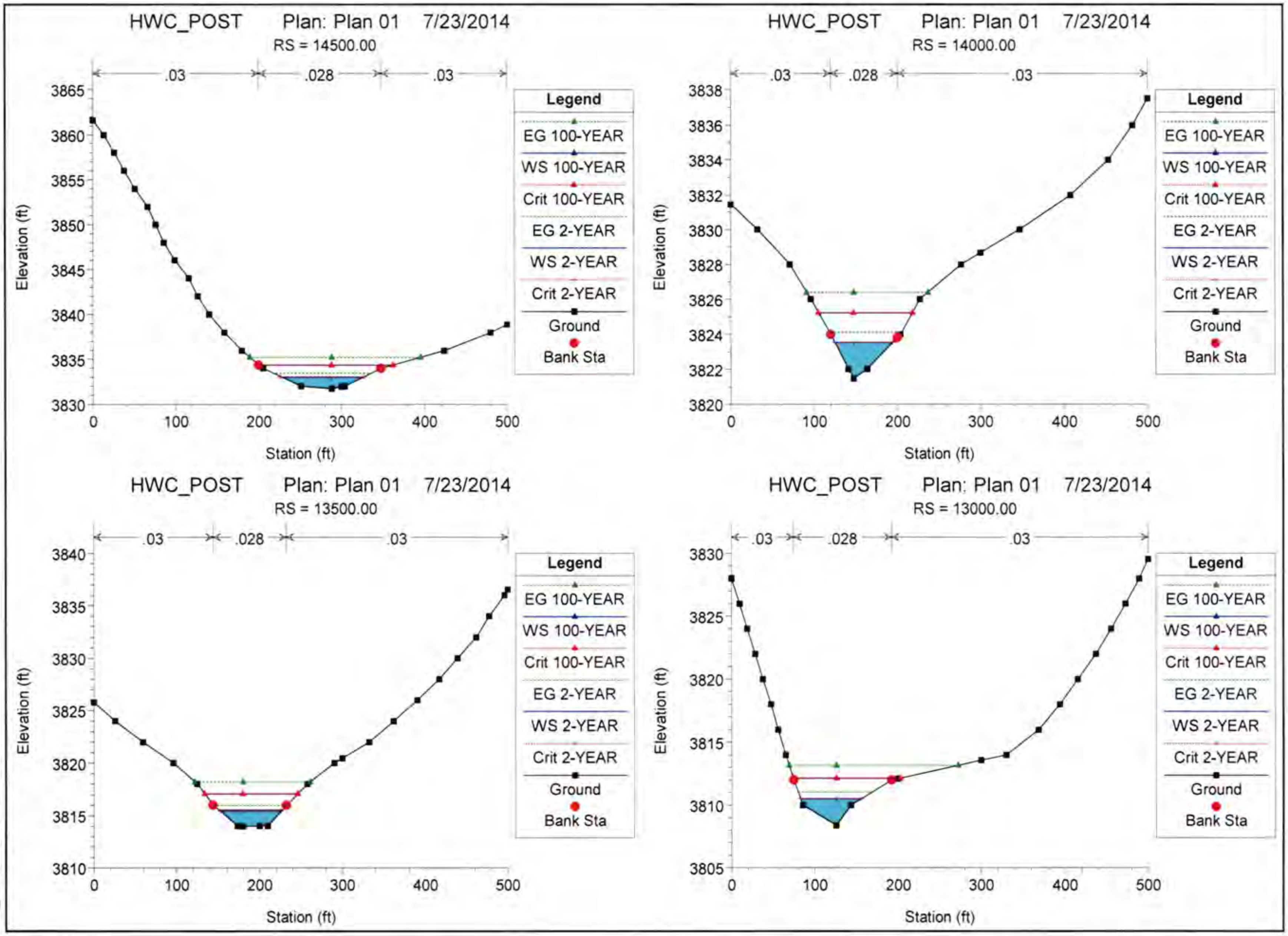
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)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Crit 100-YEAR
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WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)
HWC_POST Plan: Plan 01 7/23/2014
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HWC_POST Plan: Plan 01 7/23/2014
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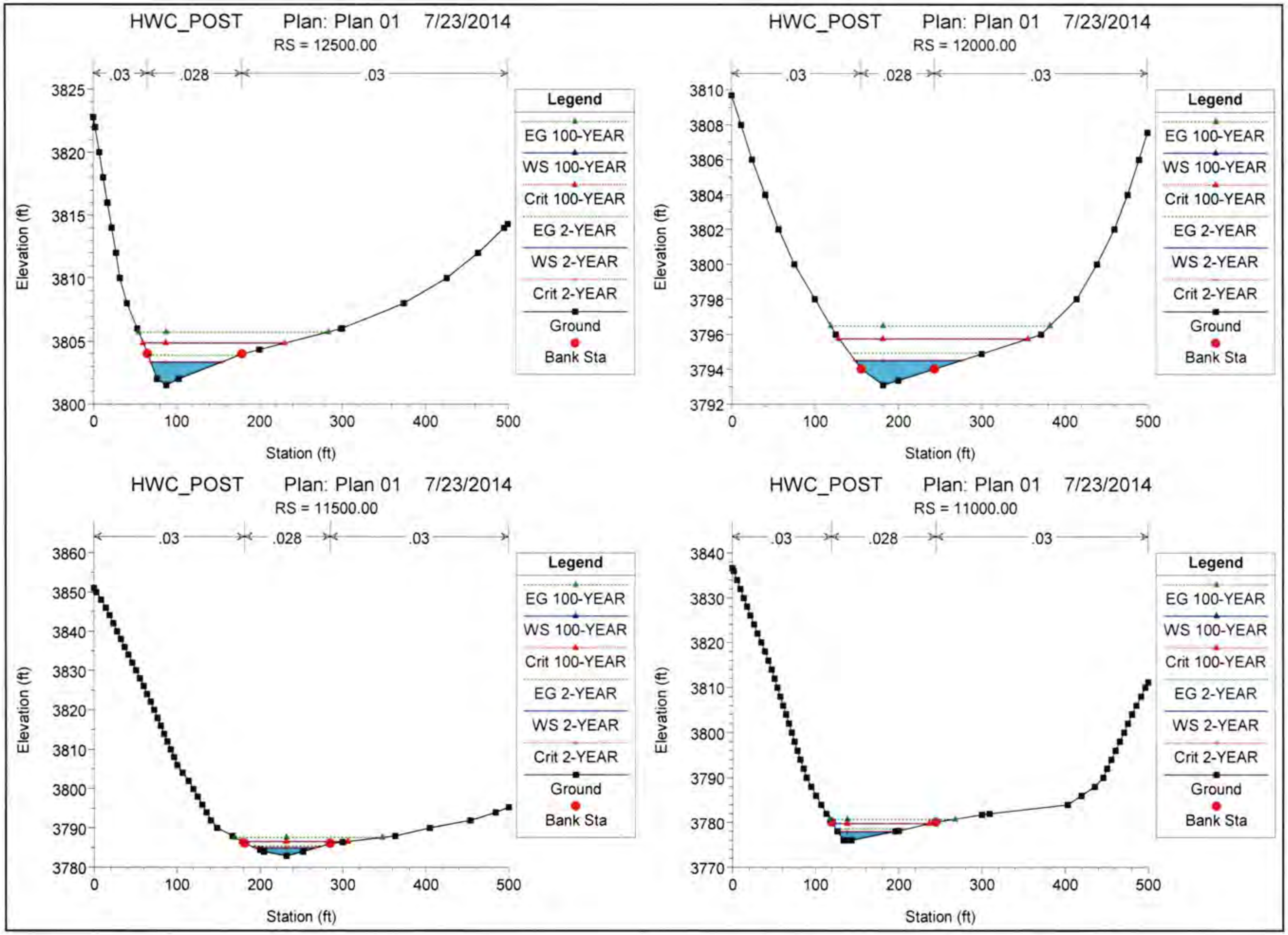
RS = 13000.00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Station (ft)
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Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
HWC_POST Plan: Plan 01 7/23/2014
RS = 12000.00
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Elevation (ft)
Station (ft)
Legend
EG 100-YEAR
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
HWC_POST Plan: Plan 01 7/23/2014
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Elevation (ft)
Station (ft)
Legend
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WS 100-YEAR
Crit 100-YEAR
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WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
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Elevation (ft)
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WS 100-YEAR
Crit 100-YEAR
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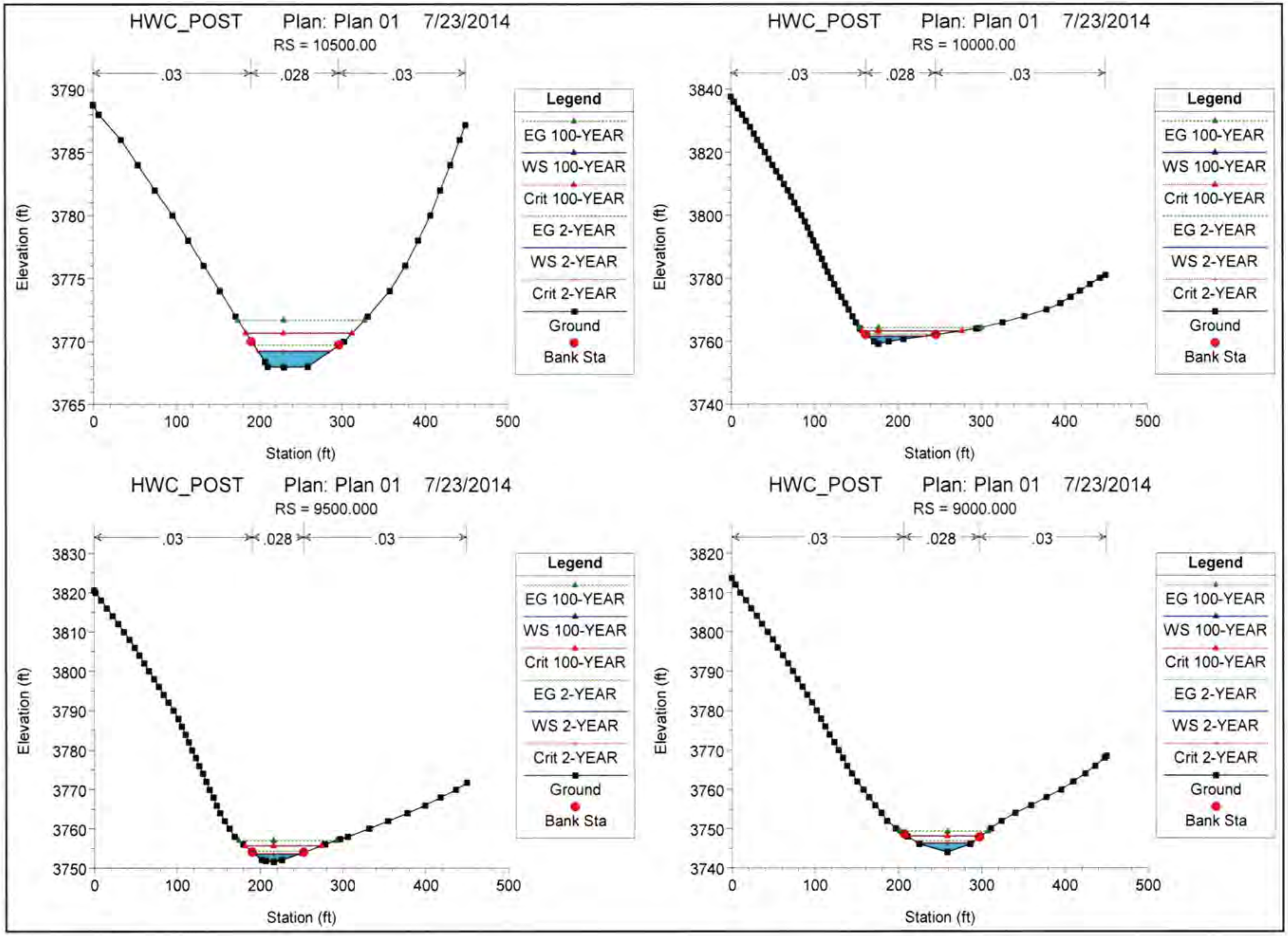
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta



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Crit 100-YEAR
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WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
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Station (ft)
HWC_POST Plan: Plan 01 7/23/2014
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WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)
HWC_POST Plan: Plan 01 7/23/2014
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Legend
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WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)
HWC_POST Plan: Plan 01 7/23/2014
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Legend
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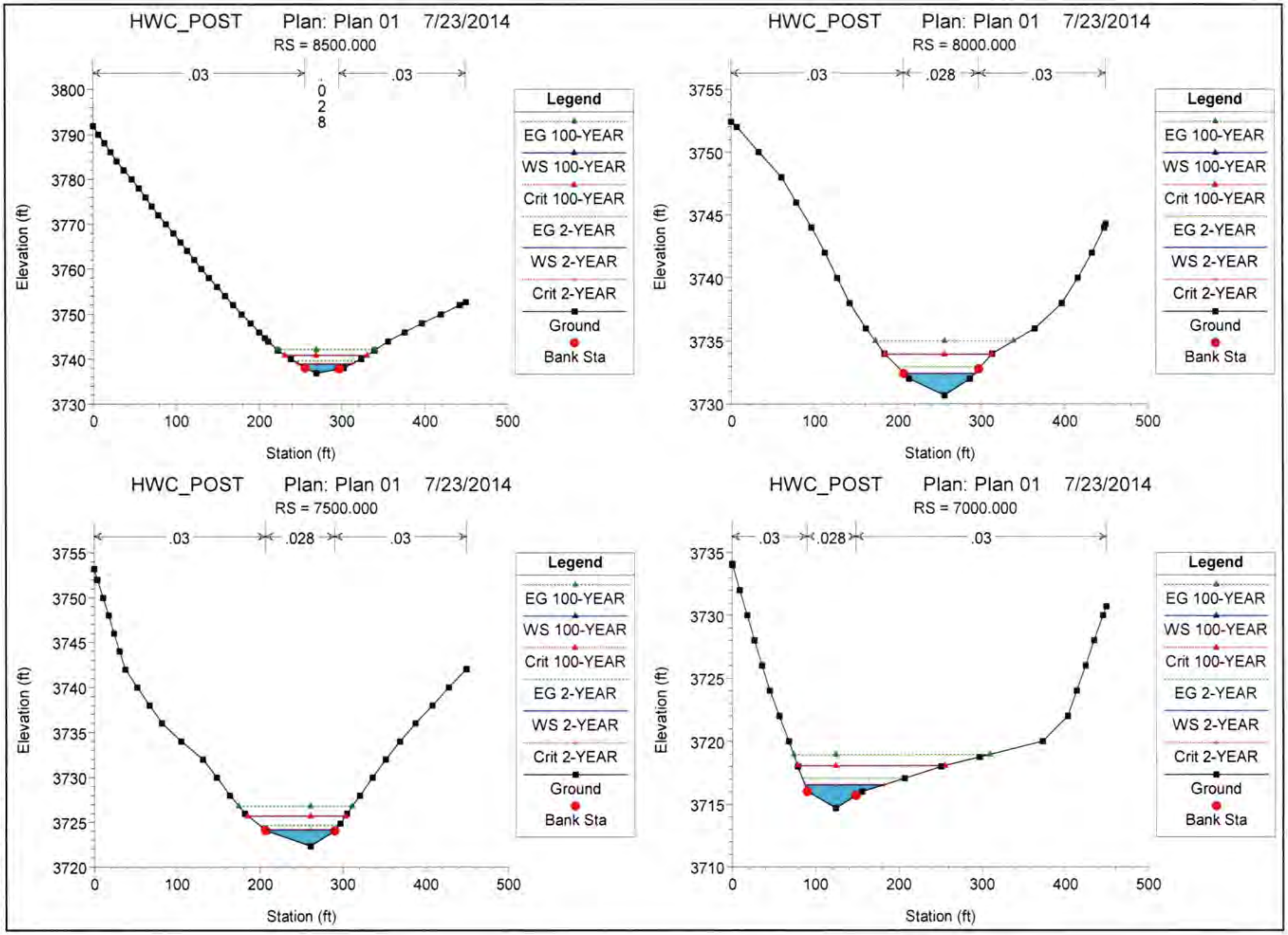
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)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WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
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RS = 8000.000
.03
.028
.03
Elevation (ft)
Station (ft)
HWC_POST Plan: Plan 01 7/23/2014
RS = 7500.000
.03
.028
.03
Elevation (ft)
Station (ft)
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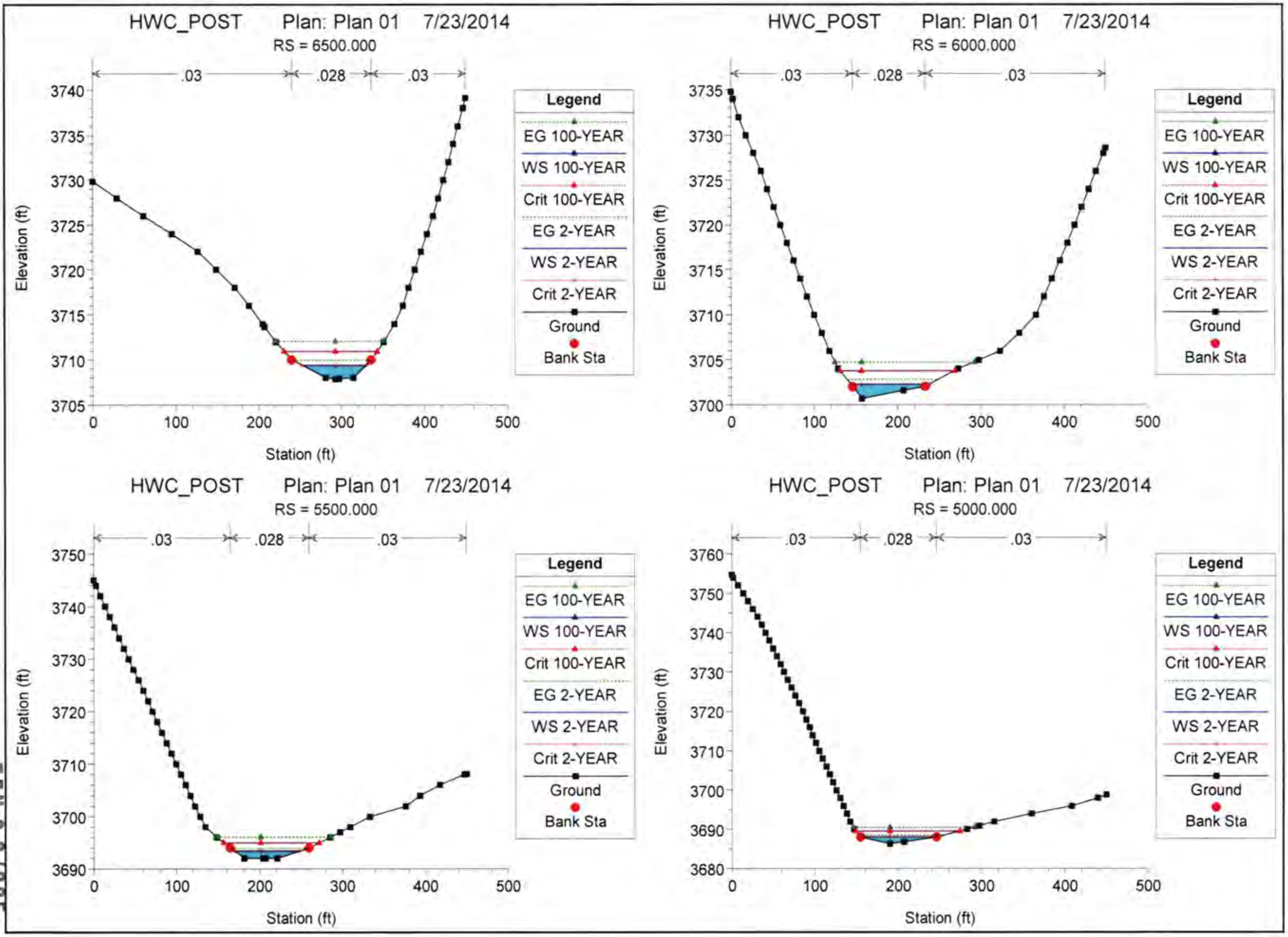
Elevation (ft)
Station (ft)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Station (ft)
Legend
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WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
HWC_POST Plan: Plan 01 7/23/2014
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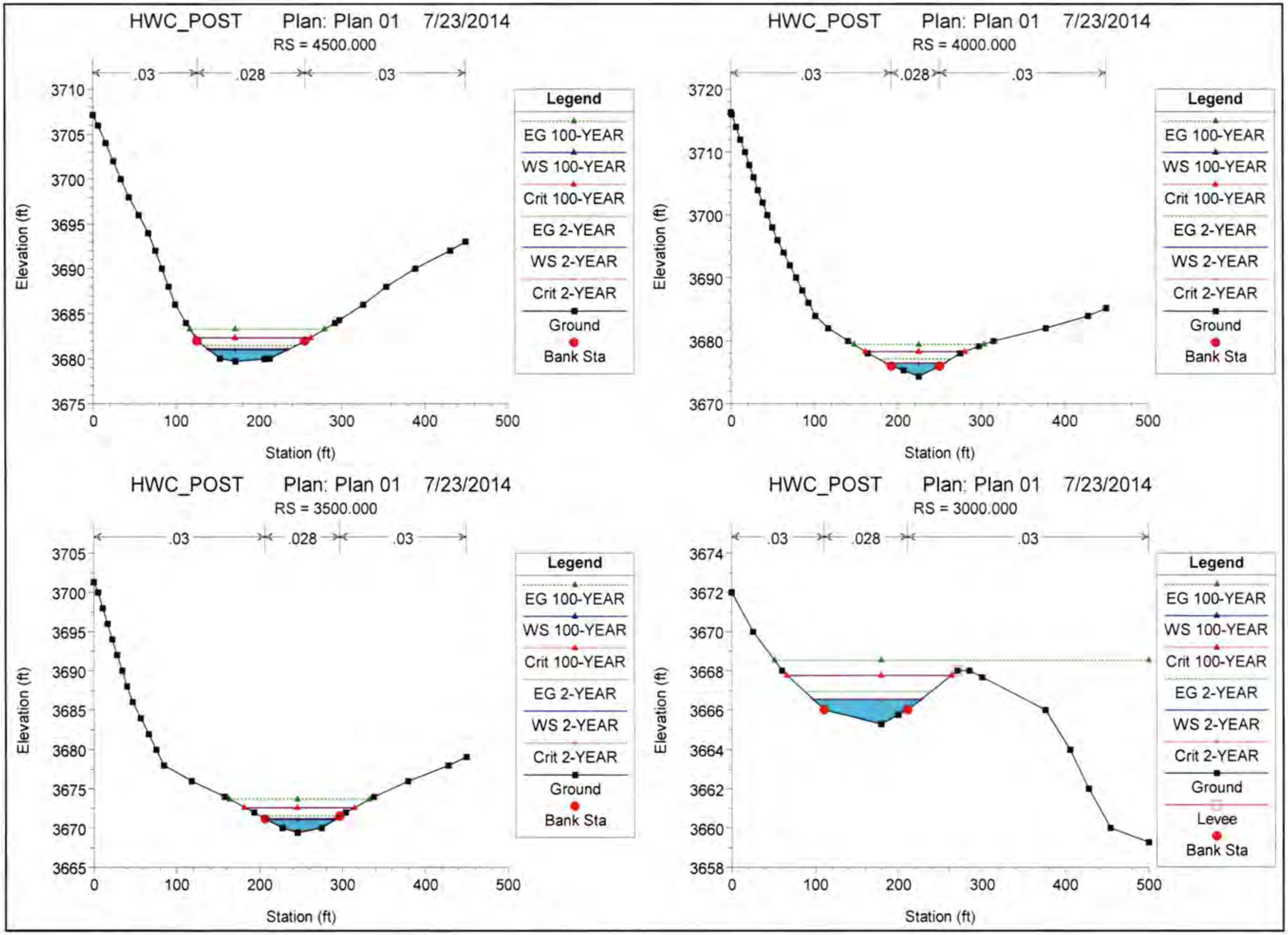
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Station (ft)
Legend
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Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
HWC_POST Plan: Plan 01 7/23/2014
RS = 4000.000
.03 .028 .03
Elevation (ft)
Station (ft)
Legend
EG 100-YEAR
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
HWC_POST Plan: Plan 01 7/23/2014
RS = 3500.000
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Elevation (ft)
Station (ft)
Legend
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WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
HWC_POST Plan: Plan 01 7/23/2014
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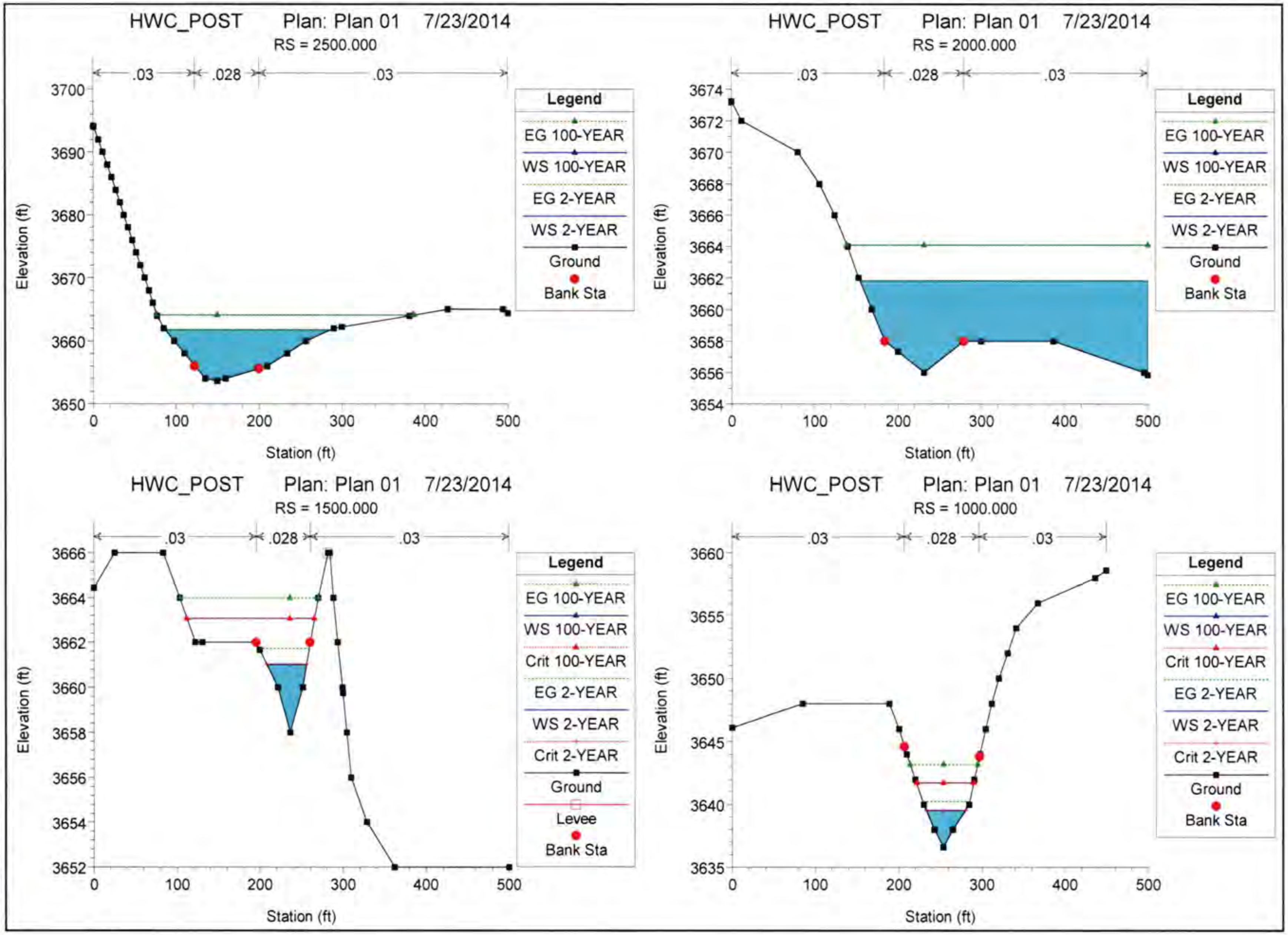
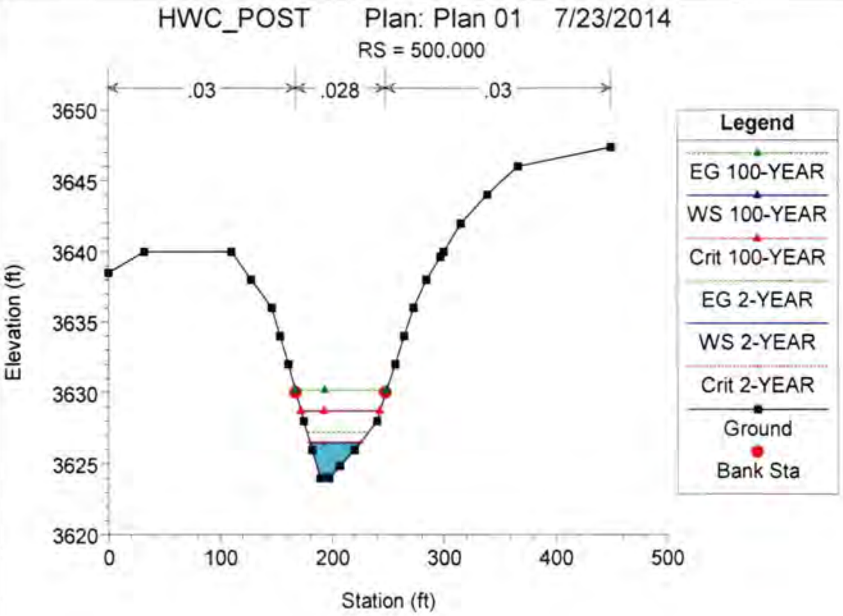
Elevation (ft)
Station (ft)
Legend
EG 100-YEAR
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Levee
Bank Sta

Scanned, 03/02/2020

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.028
.03
Elevation (ft)
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3625
3620
0
100
200
300
400
500
Station (ft)
Legend
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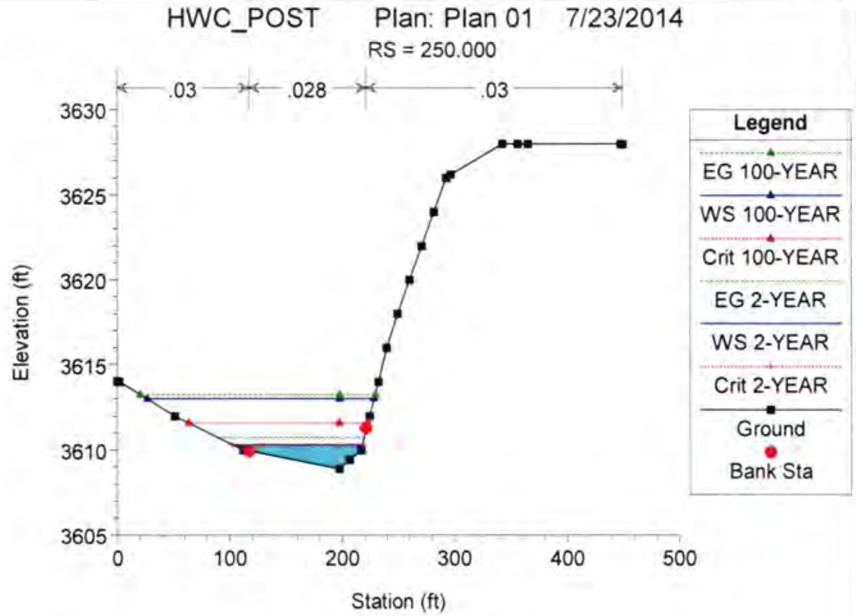
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta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0
100
200
300
400
500
Station (ft)
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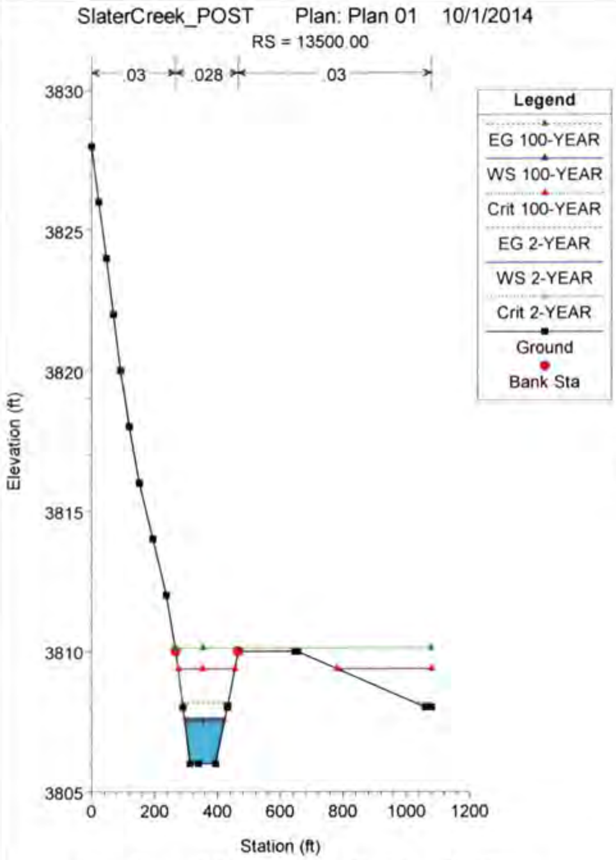
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta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Legend
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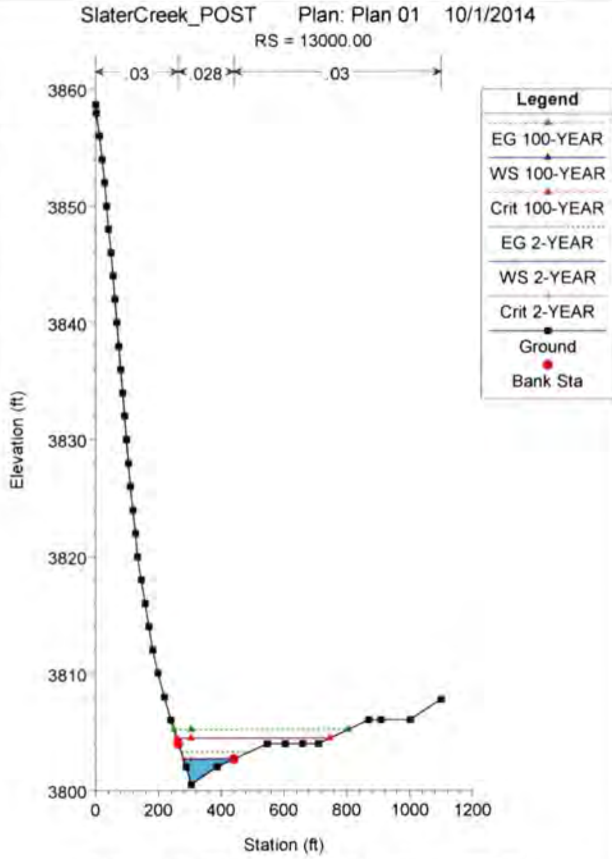
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)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Legend
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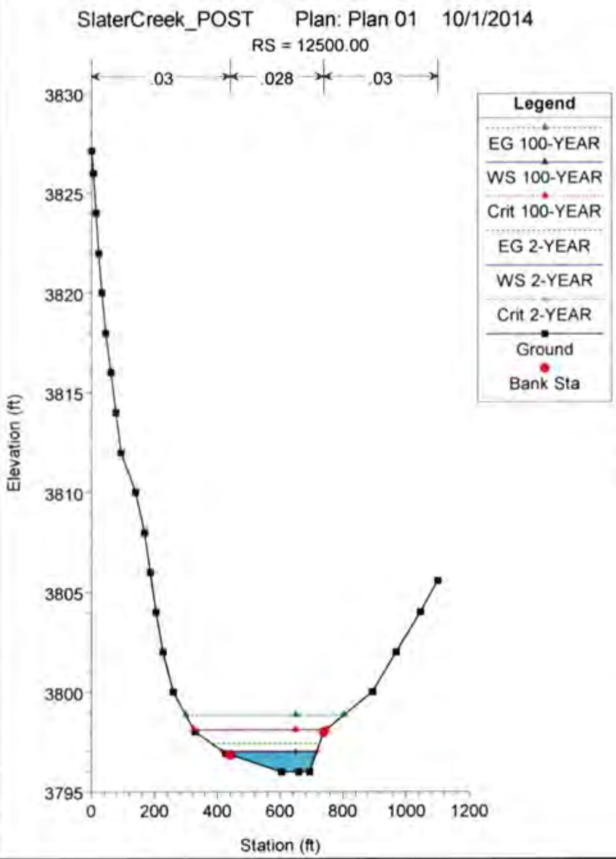
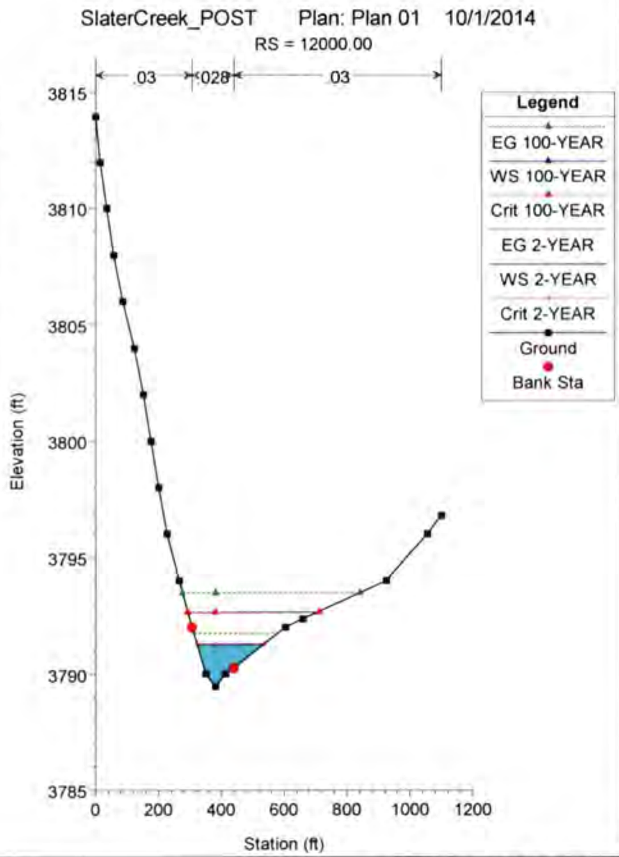
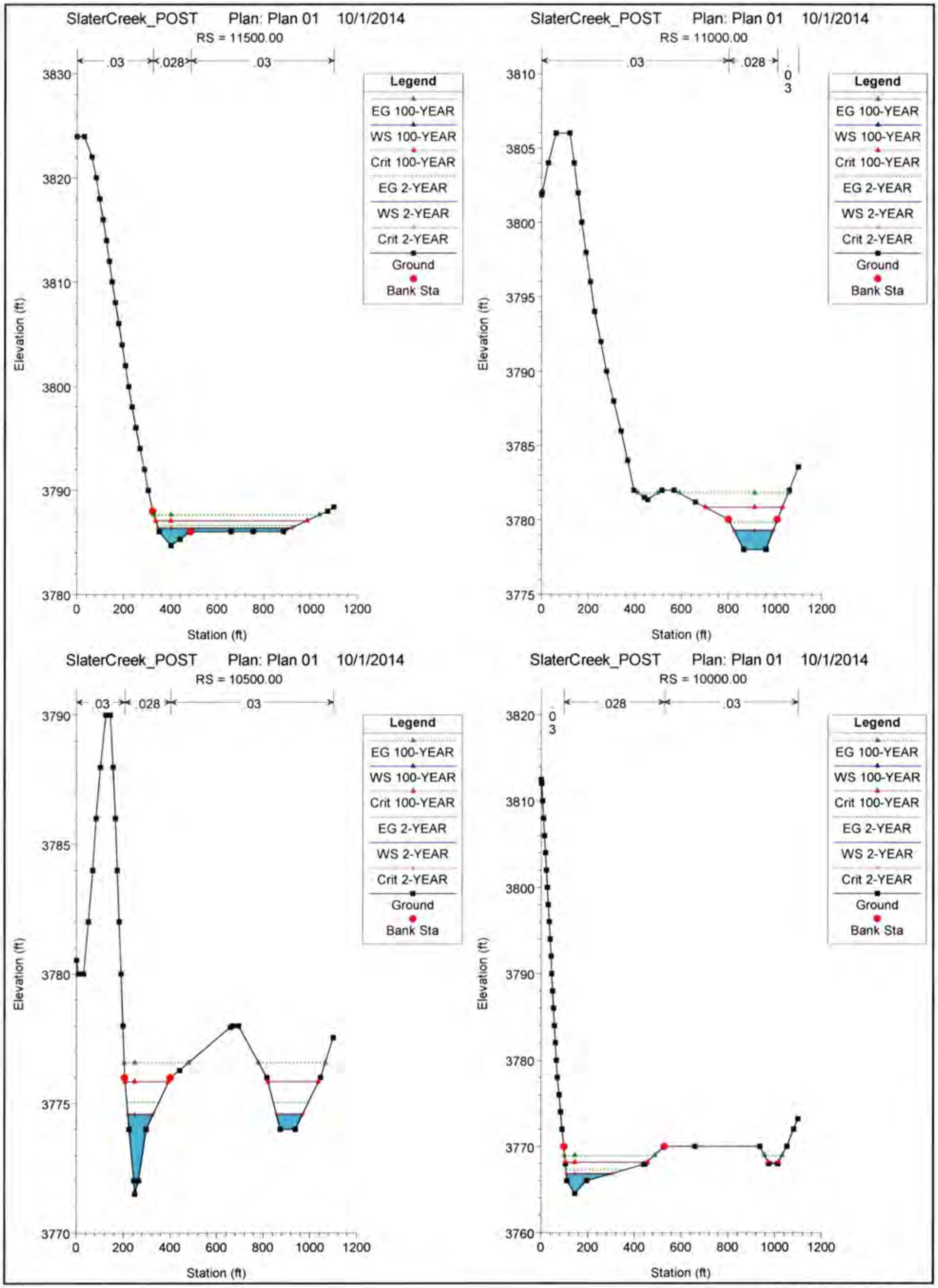
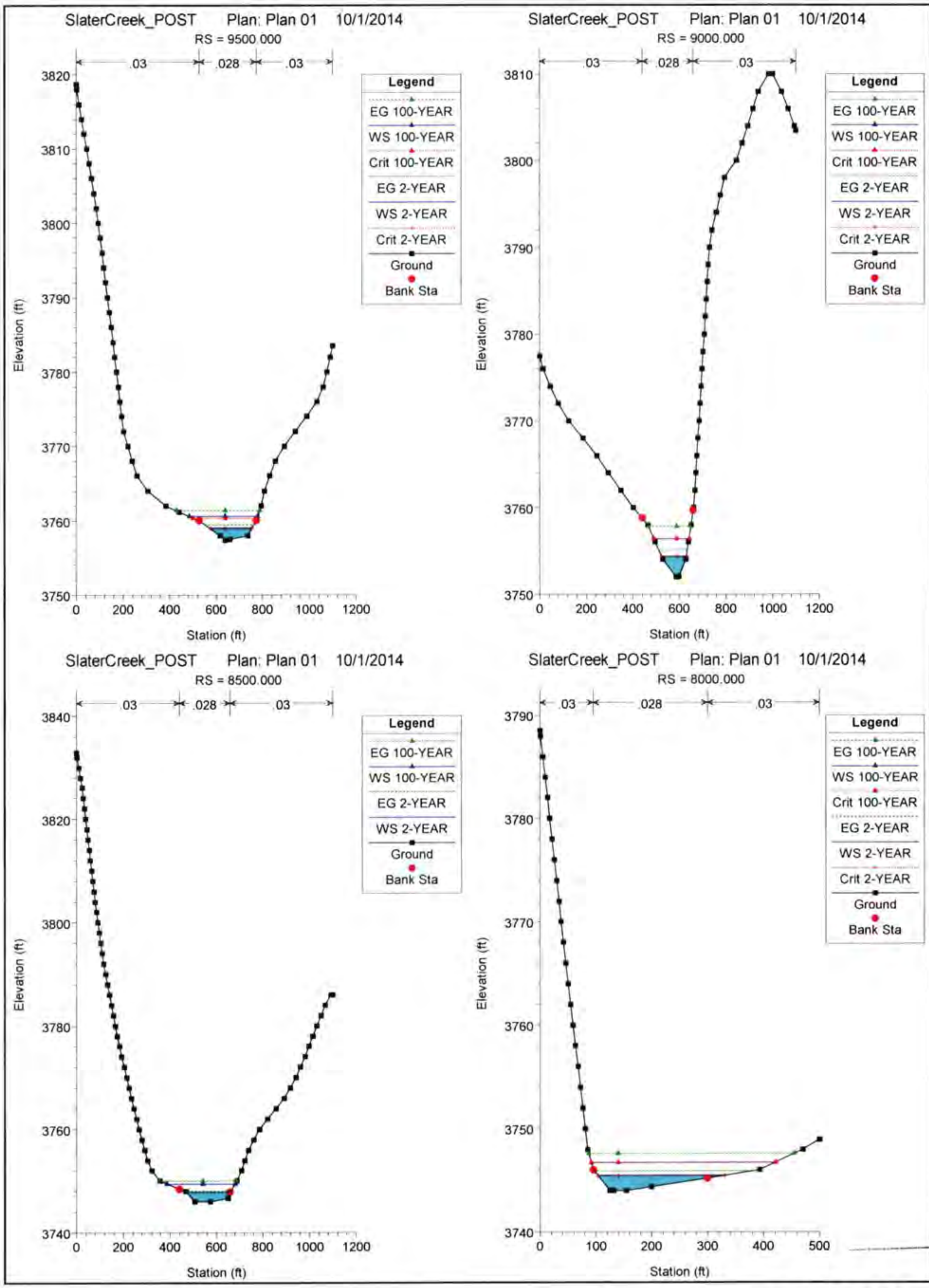
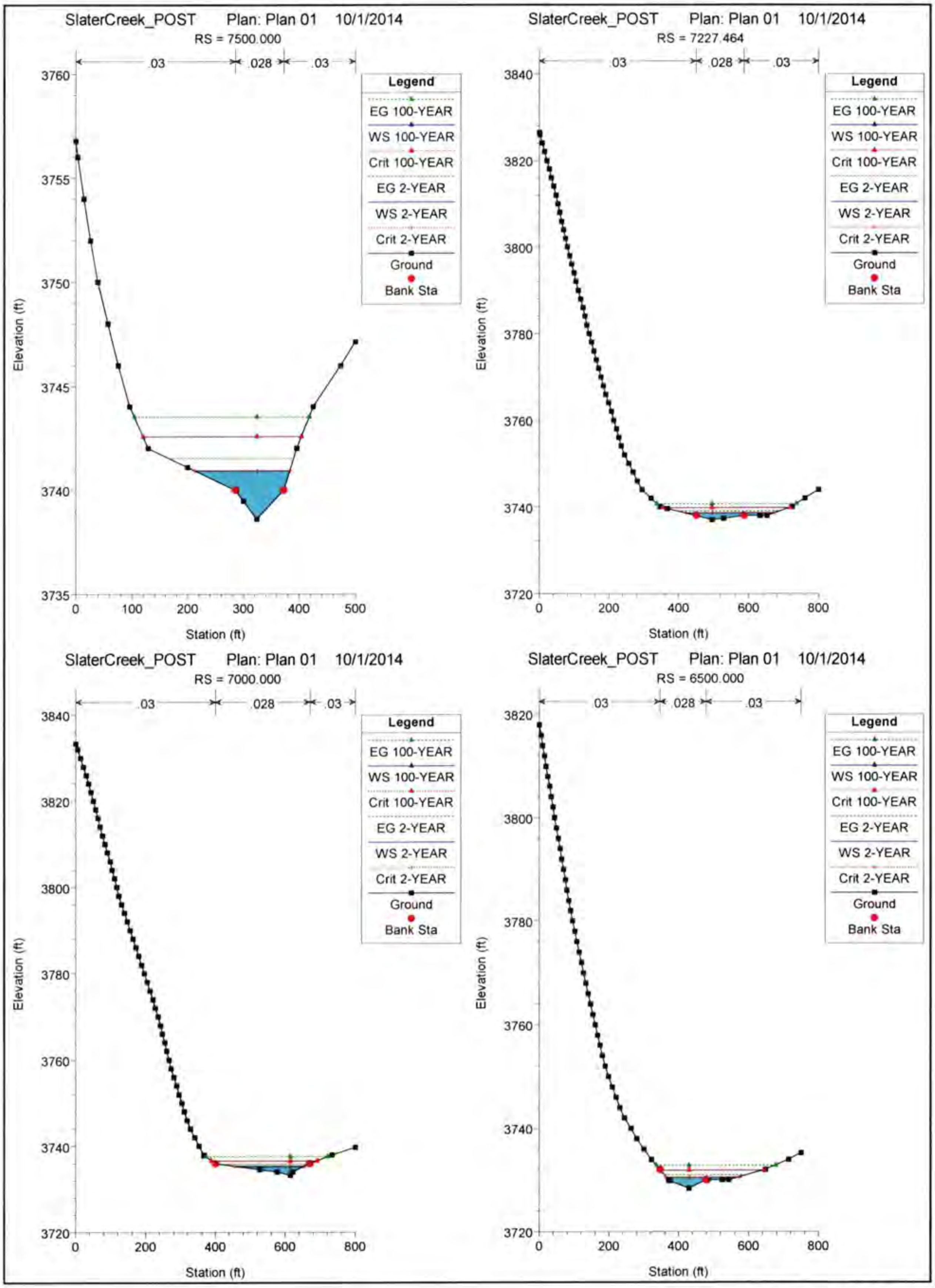
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)

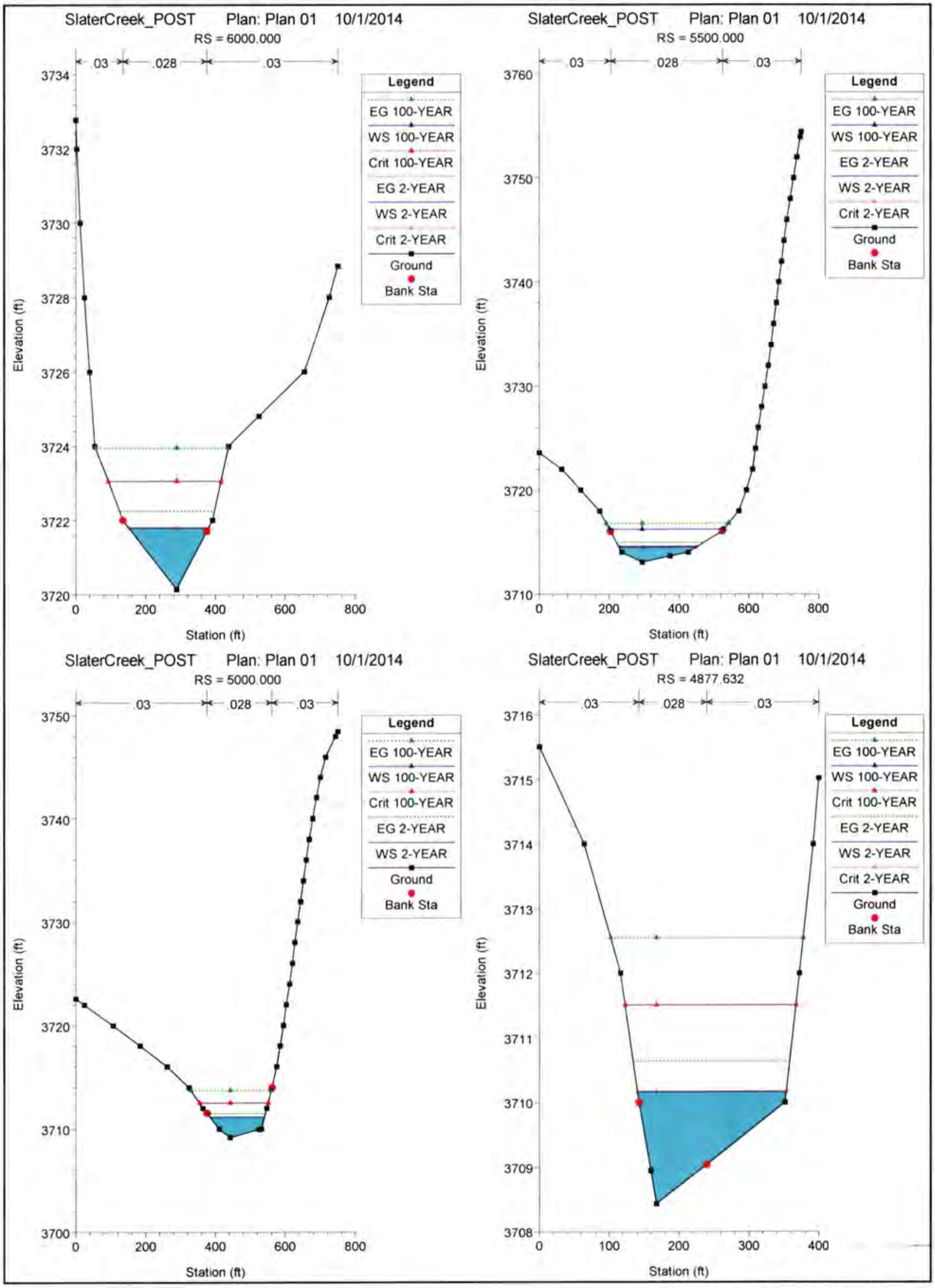

SlaterCreek_POST Plan: Plan 01 10/1/2014
RS = 12500.00
.03
.028
.03
Legend
EG 100-YEAR
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)


SlaterCreek_POST Plan: Plan 01 10/1/2014
RS = 12000.00
.03
.028
.03
Legend
EG 100-YEAR
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)


SlaterCreek_POST Plan: Plan 01 10/1/2014
RS = 11500.00
RS = 11000.00
RS = 10500.00
RS = 10000.00
.03
.028
Legend
EG 100-YEAR
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)


SlaterCreek_POST Plan: Plan 01 10/1/2014
RS = 9500.000
.03 .028 .03
Legend
EG 100-YEAR
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)
SlaterCreek_POST Plan: Plan 01 10/1/2014
RS = 9000.000
.03 .028 .03
Legend
EG 100-YEAR
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)
SlaterCreek_POST Plan: Plan 01 10/1/2014
RS = 8500.000
.03 .028 .03
Legend
EG 100-YEAR
WS 100-YEAR
EG 2-YEAR
WS 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)
SlaterCreek_POST Plan: Plan 01 10/1/2014
RS = 8000.000
.03 .028 .03
Legend
EG 100-YEAR
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)


SlaterCreek_POST Plan: Plan 01 10/1/2014
RS = 7500.000
.03 .028 .03
Legend
EG 100-YEAR
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)
SlaterCreek_POST Plan: Plan 01 10/1/2014
RS = 7227.464
.03 .028 .03
Legend
EG 100-YEAR
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)
SlaterCreek_POST Plan: Plan 01 10/1/2014
RS = 7000.000
.03 .028 .03
Legend
EG 100-YEAR
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)
SlaterCreek_POST Plan: Plan 01 10/1/2014
RS = 6500.000
.03 .028 .03
Legend
EG 100-YEAR
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)



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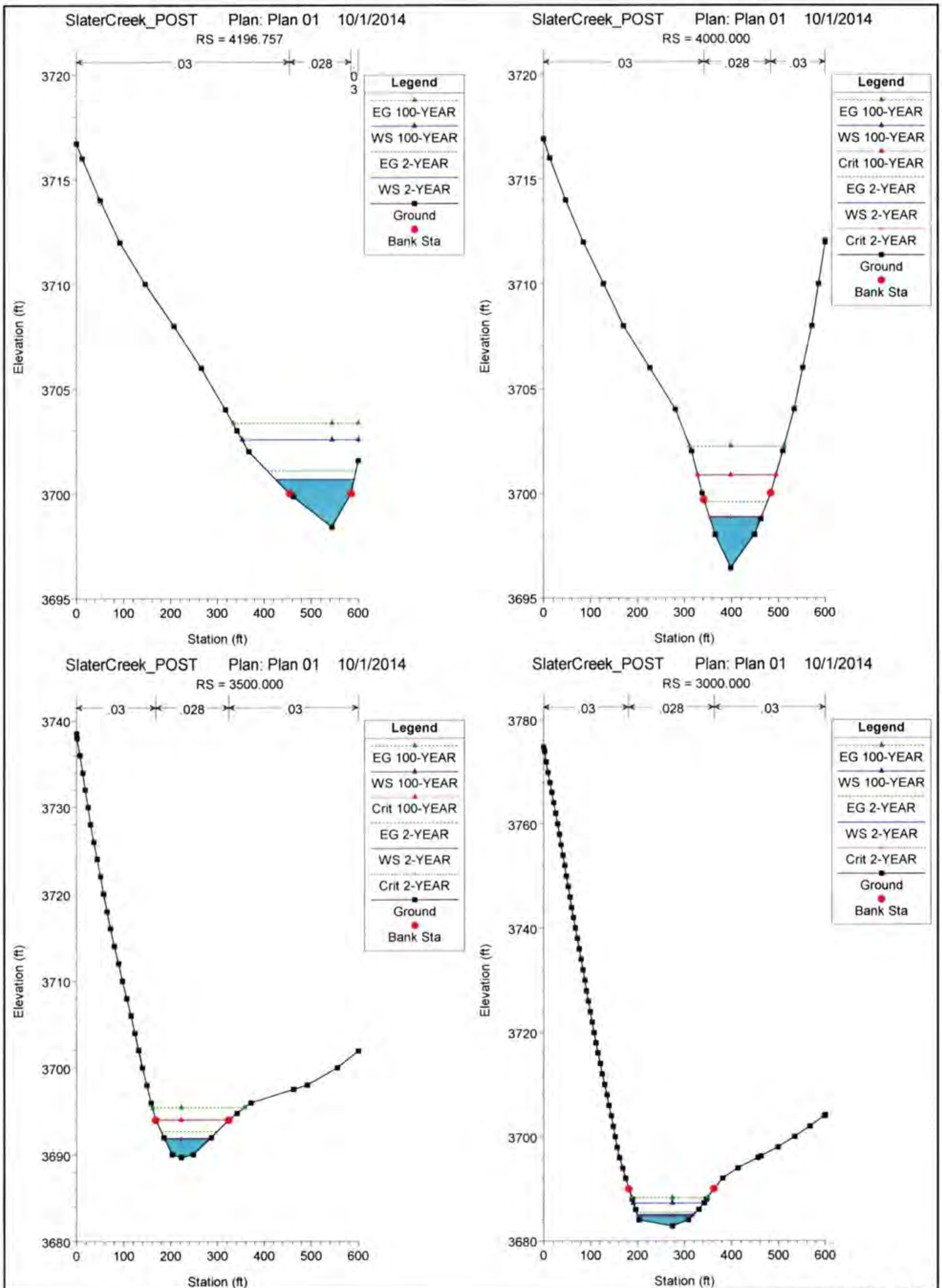
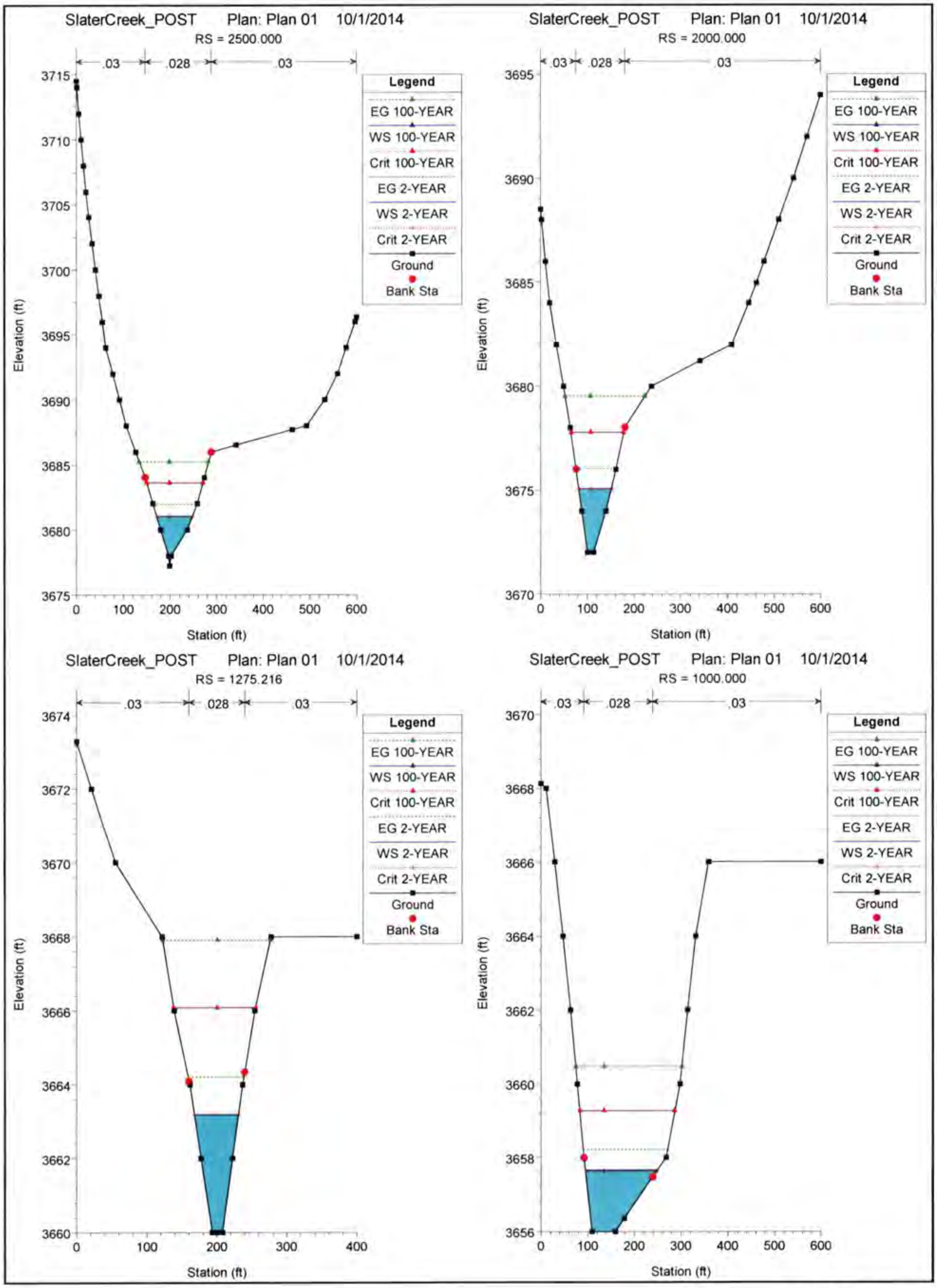
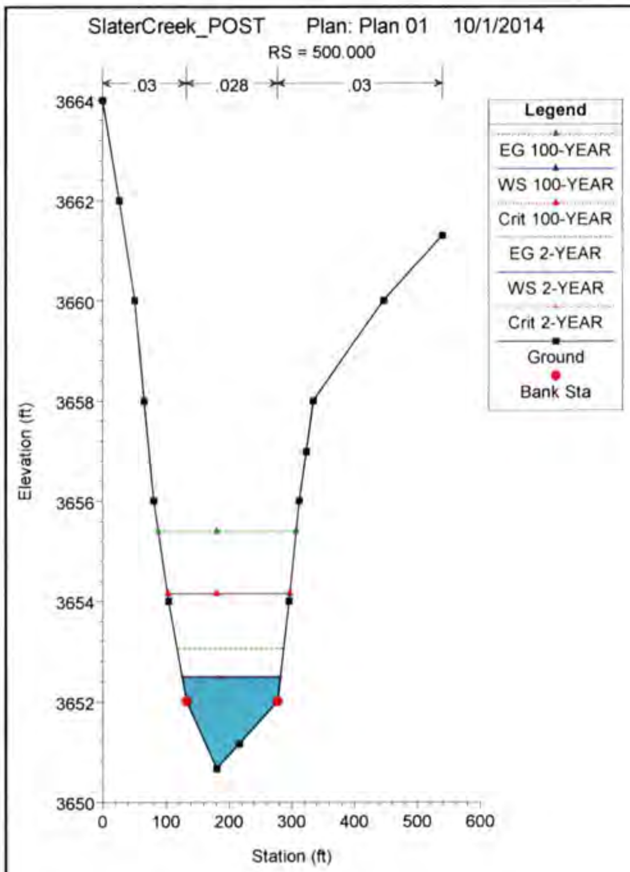
RECD NOV 14, 2014


SlaterCreek_POST Plan: Plan 01 10/1/2014
RS = 4196.757
.03 .028 .03
Legend
EG 100-YEAR
WS 100-YEAR
EG 2-YEAR
WS 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)
SlaterCreek_POST Plan: Plan 01 10/1/2014
RS = 4000.000
.03 .028 .03
Legend
EG 100-YEAR
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)
SlaterCreek_POST Plan: Plan 01 10/1/2014
RS = 3500.000
.03 .028 .03
Legend
EG 100-YEAR
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)
SlaterCreek_POST Plan: Plan 01 10/1/2014
RS = 3000.000
.03 .028 .03
Legend
EG 100-YEAR
WS 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
Station (ft)



TFN 6 2/025
RECD NOV 14, 2014


SlaterCreek_POST Plan: Plan 01 10/1/2014
RS = 500.000
.03
.028
.03
Legend
EG 100-YEAR
WS 100-YEAR
Crit 100-YEAR
EG 2-YEAR
WS 2-YEAR
Crit 2-YEAR
Ground
Bank Sta
Elevation (ft)
3664
3662
3660
3658
3656
3654
3652
3650
0
100
200
300
400
500
600
Station (ft)

LEGEND

BROOK MINE PERMIT BOUNDARY
DISTURBANCE BOUNDARY
20+00 HEC-RAS CROSS SECTION
STREAM

CERTIFICATE OF ENGINEER

I, Jeffrey G. Barron, hereby certify that this drawing was prepared by myself or by engineers under my direct supervision and that it correctly represents the conditions described in the accompanying application which is designed to meet the requirements of the Wyoming Environmental Quality Act and its accompanying regulations.

Professional Engineer (Civil)
JEFFREY G. BARRON
13033
DATE 10/3/2018
WYOMING

N

0 500 1,000 1,500 2,000
GRAPHIC SCALE (FEET)
C.I. = 5'

RAMACO

BROOK MINE
SHERIDAN COUNTY, WY
1101 SUGARVIEW DR. STE. 201
SHERIDAN, WY 82801

REVISIONS	
Date	Description
10/15	ROUND 2 COMMENTS
08/18	ROUND 7 COMMENTS

ADDENDUM RP-3
EXHIBIT 1

TFN 6 2/025
RECD 10-25-18

POSTMINE HEC-RAS CROSS SECTION LOCATIONS

Drawn By: DCJ
Checked By: JGB
Date: 11/1/14

WWC ENGINEERING
www.wwcengineering.com

FILE: RP-3_1_HEC_XSEC_LOC.dwg

K:\Sheridan\RAMACO\13139\ACAD_WY83EC\DWGS\DWGS_REC_PLAN\ADDUNDUM\RP-3_1_HEC_XSEC_LOC.dwg 10/1/2018 4:40:30 PM dave johnson